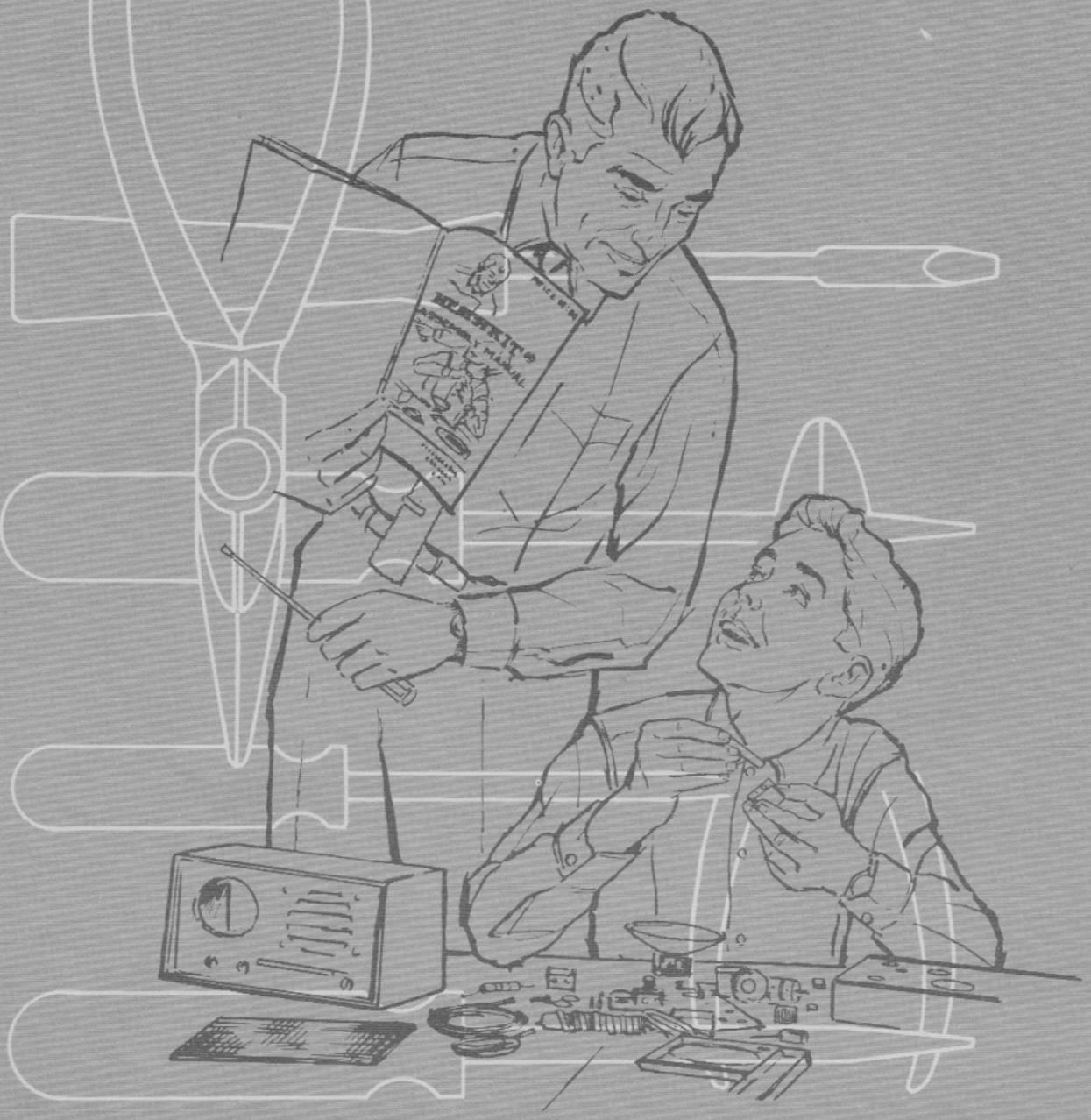
MODEL

IC-2108 Electronic Desk-Top Calculator

HEATHKIT®

ASSEMBLY MANUAL



HEATH COMPANY · BENTON HARBOR, MICHIGAN

HEATHKIT®

PRICE $2.00

I-595-1538

Dear Customer:

The Heathkit electronic product you have purchased is one of the best performing electronic products in the world.

Here's how we aim to keep it that way:

Your Heathkit Warranty

During your first 90 days of ownership, any parts which we find are defective, either in materials or workmanship, will be replaced or repaired free of charge. And we'll pay shipping charges to get those parts to you — anywhere in the world.

If we determine a defective part has caused your Heathkit electronic product to need other repair, through no fault of yours, we will service it free — at the factory, at any retail Heathkit Electronic Center, or through any of our authorized overseas distributors.

This protection is exclusively yours as the original purchaser. Naturally, it doesn't cover damage by use of acid-core solder, incorrect assembly, misuse, fire, flood or acts of God. But, it does insure the performance of your Heathkit electronic product anywhere in the world — for most any other reason.

After-Warranty Service

What happens after warranty? We won't let you down. If your Heathkit electronic product needs repairs or you need a part, just write or call the factory, your nearest retail Heathkit Electronic Center, or any Heath authorized overseas distributor. We maintain an inventory of replacement parts for each Heathkit model at most locations — even for many models that no longer appear in our current product line-up. Repair service and technical consultation are available through all locations.

We hope you'll never need our repair or replacement services, but it's nice to know you're protected anyway — and that cheerful help is nearby.

Sincerely,

HEATH COMPANY
Benton Harbor, Michigan 49022

Assembly and Operation of the

HEATHKIT

ELECTRONIC DESK-TOP CALCULATOR

MODEL IC-2108

TABLE OF CONTENTS

HEATH COMPANY
BENTON HARBOR, MICHIGAN 49022

INTRODUCTION

The Heathkit Model IC-2108 Electronic Desk-Top Calculator adds, subtracts, multiplies, and divides quickly and accurately with just a touch of your finger. This calculator will quietly compute your figures and display the answer on the large, easy-to-read, digital readout.

The readout tubes are mounted on a sloped surface to reduce glare. The keyboard provides easy operation and makes it simple for you to switch from a standard adding machine keyboard to the calculator.

The 8-digit readout allows you to handle practically all numbers commonly encountered. You can select the location of the decimal point in the answer, or allow it to be placed automatically in the correct location for each calculation.

A constant number (K) can be entered into the Calculator to speed up repetitive calculations in multiplication and division. By sequencing the basic functions of the Calculator and using a constant (K), you can quickly complete complex mathematical calculations that otherwise would be very lengthy and tedious operations.

The low-profile styling and small size of this Calculator make it ideally suited for use almost anywhere. Whether you use this Calculator in business or for personal applications, you will find it to be a useful and accurate tool.

Refer to the "Kit Builders Guide" for complete information on unpacking, parts identification, tools, wiring, soldering, and step-by-step assembly procedures.

PARTS LIST

Check each part against the following list. The key numbers correspond to the numbers in the Parts Pictorial (fold-out from Page 5). Any part that is packaged in an individual envelope with the part number on it should be placed back in the envelope after it is identified until it is called for in a step.

CAUTION: The large integrated circuit (#443-621) can be damaged by static voltage. Do not handle it until you are told to do so.

To order replacement parts: Use the Parts Order Form furnished with this kit. If one is not available, see "Replacement Parts" in the "Kit Builders Guide."

KEY No.	PART No.	PARTS Per Kit	DESCRIPTION	PRICE Each
RESISTORS				
NOTE: The following resistor tolerances are 10% unless otherwise noted. 10% is indicated by a fourth color band, silver; 5% is indicated by a gold band.				
1/4-Watt				
A1	1-16-12	1	180 kΩ (brown-gray-yellow)	.10
1/2-Watt				
A2	1-53	1	68 Ω, 5% (blue-gray-black)	.10
A2	1-57	3	2200 Ω, 5% (red-red-red)	.10
A2	1-113	13	5600 Ω, 5% (green-blue-red)	.10
A2	1-20	20	10 kΩ (brown-black-orange)	.10
A2	1-69	2	18 kΩ (brown-gray-orange)	.10
A2	1-60	1	68 kΩ (blue-gray-orange)	.10
A2	1-121	28	120 kΩ (brown-red-yellow)	.10
A2	1-30	9	270 kΩ (red-violet-yellow)	.10
A2	1-33	8	470 kΩ (yellow-violet-yellow)	.10
A2	1-35	9	1 MΩ (brown-black-green)	.10
A2	1-120	3	12 MΩ (brown-red-blue)	.10

KEY No.	PART No.	PARTS Per Kit	DESCRIPTION	PRICE Each
CAPACITORS				
C1	21-171	2	680 pF disc.	.10
C1	21-140	10	.001 μF disc	.10
C1	21-31	1	.02 μF disc	.10
C2	27-60	1	.22 μF Mylar*	.25
C3	25-199	1	500 μF electrolytic	.60
C4	25-30	1	20-20 μF electrolytic	1.00
DIODES-TRANSISTORS-INTEGRATED CIRCUIT				
D1	57-27	2	1N2071 silicon diode	.50
D1	57-65	1	1N4002 silicon diode	.20
D1	56-97	2	1N3017 zener diode	.35

NOTE: Transistors and integrated circuits are marked for identification in one of the following four ways:

1. Part number.
2. Type number. (In integrated circuits this refers only to the numbers; the letters may vary.)
3. Part number and type number.
4. Part number with a type number other than the one listed.

D2	417-294	9	MPS-A42 transistor	.60
D2	417-295	9	MPS-L51 transistor	.50
D2	417-801	12	MPS-A20 transistor	.20
D3	443-621	1	TMS0119 integrated circuit DO NOT OPEN UNTIL INSTRUCTED TO DO SO.	23.30
HARDWARE				
#2 Hardware				
E1	250-420	5	2-32 x 1/4" self-tapping screw	.05
#4 Hardware				
E2	250-389	6	4-40 x 3/4" screw	.05
#6 Hardware				
E3	250-56	4	6-32 x 1/4" screw	.05
E4	250-89	2	6-32 x 3/8" screw	.05
E5	250-11	4	6-32 x 1/2" flat head screw	.05
E6	250-559	4	6-20 x 5/8" self-tapping screw	.05

*DuPont Registered Trademark

KEY No.	PART No.	PARTS Per Kit	DESCRIPTION	PRICE Each
#6 Hardware (cont'd.)				
E7	252-3	10	6-32 nut	.05
E8	254-1	12	#6 lockwasher	.05
SWITCHES				
	64-620	1	One set of keyboard switches consisting of:	
F1	64-622	1	1 key	.65
F1	64-623	1	2 key	.65
F1	64-624	1	3 key	.65
F1	64-625	1	4 key	.65
F1	64-626	1	5 key	.65
F1	64-627	1	6 key	.65
F1	64-628	1	7 key	.65
F1	64-629	1	8 key	.65
F1	64-630	1	9 key	.65
F1	64-621	1	• key	.65
F1	64-635	1	− key	.65
F1	64-637	1	÷ key	.65
F1	64-633	1	C key	.65
F1	64-632	1	C_D key	.65
F1	64-634	1	+ key	.65
F1	64-636	1	X key	.65
F2	64-631	1	0 key	.65
F2	64-638	1	= key	.65

NOTE: The "6" and "9" keys are identical.

F3	60-82	3	Rocker switch	.65
WIRE				
	340-11	1	Bare wire	.05/ft
	344-59	1	White wire	.05/ft
	89-44	1	Line cord	.55
MISCELLANEOUS				
	92-86*	1	Cabinet top	
	92-87*	1	Cabinet bottom	
	85-1297-1	1	Main circuit board	2.55
	85-1298-1	1	Key circuit board	1.45
	85-1304-1	1	Readout circuit board	1.10
G1	411-290	3	Display tube	7.30
G2	446-603	1	Window	.90
	54-831	1	Power transformer	4.60
G3	432-134	90	Connector pin (5 extra)	.10

*Write to Heath Company for price information.

KEY No.	PART No.	PARTS Per Kit	DESCRIPTION	PRICE Each
Miscellaneous (cont'd.)				
G4	10-392	1	50 kΩ control	.55
G5	204-1901*	2	Angle bracket	
G6	434-223	1	IC socket	1.75
	73-39	1	Foam tape	.10/ft
G7	255-49	6	Metal spacer	.05
G8	258-167	3	Window bracket	.05
G9	260-65	2	Fuse clip	.10
G10	261-1	4	Rubber foot	.05
G11	412-11	1	Neon lamp	.20
	421-26	1	1/8-ampere slow-blow fuse	.30
G12	490-5	1	Nut starter	.10
			Solder (Additional 3' rolls of solder can be ordered under part number 331-13 for $.25 each.)	

*Write to Heath Company for price information.

KEY No.	PART No.	PARTS Per Kit	DESCRIPTION	PRICE Each
PRINTED MATERIAL				
	390-1011	1	Power requirements label	.10
	391-34	1	Blue and white label	
	597-260	1	Parts Order Form	
	597-308	1	Kit Builders Guide	
	597-1278	1	Operation Manual	2.00
			Assembly Manual (See front cover for part number.)	2.00

The above prices apply only on purchases from the Heath Company where shipment is to a U.S.A. destination. Add 10% (minimum 25 cents) to the price when ordering from a Heathkit Electronic Center to cover local sales tax, postage, and handling. Outside the U.S.A., parts and service are available from your local Heathkit source and will reflect additional transportation, taxes, duties, and rates of exchange.

ASSEMBLY NOTES

1. Before you start to assemble this kit, read the wiring, soldering, and step-by-step assembly information in the "Kit Builders Guide."

2. Due to the small foil area around the circuit board holes and the small areas between foils, it will be necessary to use the utmost care to prevent solder bridges between adjacent foil areas. Use only a minimum amount of solder and use no larger than a 25-watt soldering iron with a small tip. Allow it to reach operating temperature, and then apply it only long enough to make a good solder connection.

3. If a small wattage, small-tip soldering iron is not available, proceed as follows: Be sure your soldering iron is cool. Wrap the large bare wire (supplied) tightly around the soldering iron tip as shown in Figure 1. Allow approximately 1/4" of wire to extend beyond the end of the soldering iron. Cut the wire end to a chisel shape as shown. Occasionally apply solder to the turns of large bare wire to achieve a good heat transfer.

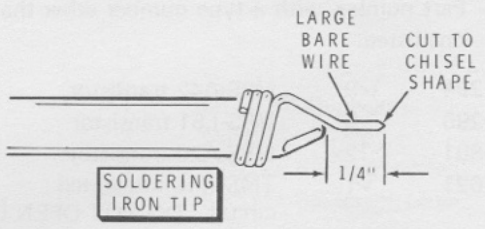


Figure 1

4. Resistors will be called out by their resistance value in Ω, kΩ, or MΩ, and color code.

5. Capacitors will be called out by their capacitance value (in pF or μF) and type (disc, Mylar, or electrolytic).

STEP-BY-STEP ASSEMBLY

START

NOTE: Be sure you have read the "Assembly Notes" (Page 4) before you perform the following steps.

Position the readout circuit board lettered-side-up as shown. Then complete each step on the following Pictorials.

( ) 18 kΩ (brown-gray-orange).

( ) 470 kΩ (yellow-violet-yellow).

( ) 5600 Ω, 5% (green-blue-red).

( ) 470 kΩ (yellow-violet-yellow).

( ) 5600 Ω, 5% (green-blue-red).

( ) 470 kΩ (yellow-violet-yellow).

( ) 5600 Ω, 5% (green-blue-red).

( ) 470 kΩ (yellow-violet-yellow).

( ) 5600 Ω, 5% (green-blue-red).

( ) Solder all leads to the foil and cut off the excess lead lengths. NOTE: Save these cutoff resistor leads, some of them will be used later.

( ) 470 kΩ (yellow-violet-yellow).

( ) 5600 Ω, 5% (green-blue-red).

( ) 470 kΩ (yellow-violet-yellow).

( ) 12 MΩ (brown-red-blue).

( ) 12 MΩ (brown-red-blue).

( ) 12 MΩ (brown-red-blue).

( ) 5600 Ω, 5% (green-blue-red).

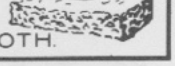
( ) 470 kΩ (yellow-violet-yellow).

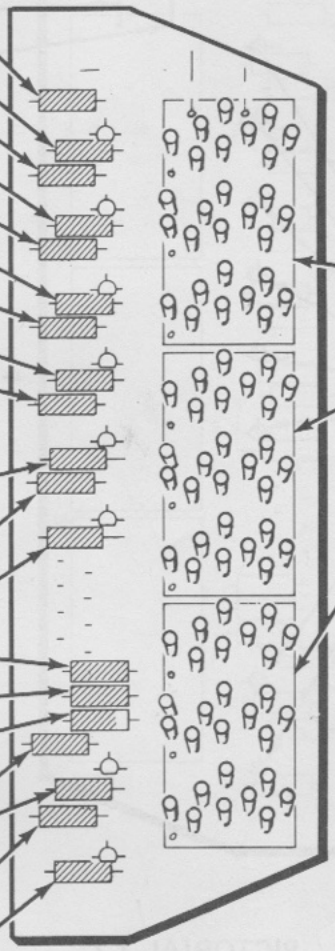
( ) 5600 Ω, 5% (green-blue-red).

( ) 470 kΩ (yellow-violet-yellow).

( ) Solder all leads to the foil and cut off the excess lead lengths.

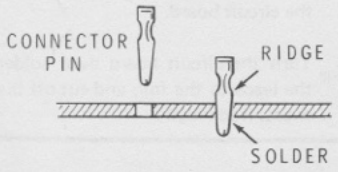
FOR GOOD SOLDER CONNECTIONS, YOU MUST **KEEP THE SOLDERING IRON TIP CLEAN.** WIPE IT OFTEN WITH A DAMP SPONGE OR CLOTH.





CONTINUE

NOTE: To install the following connector pins, insert the pin until the ridge is against the board. Make sure all of the pins are straight; then solder them to the foil. Do not install pins in the small holes.

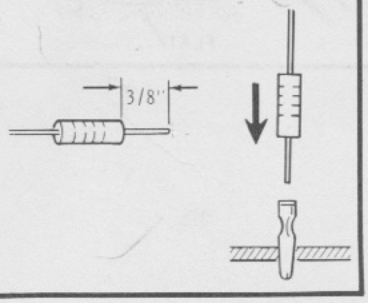


( ) Install 28 connector pins at V101.

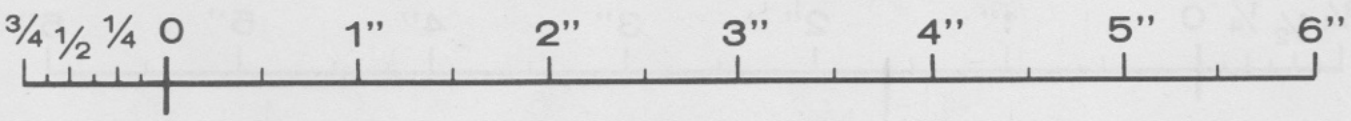
( ) Install 28 connector pins at V102.

( ) Install 28 connector pins at V103.

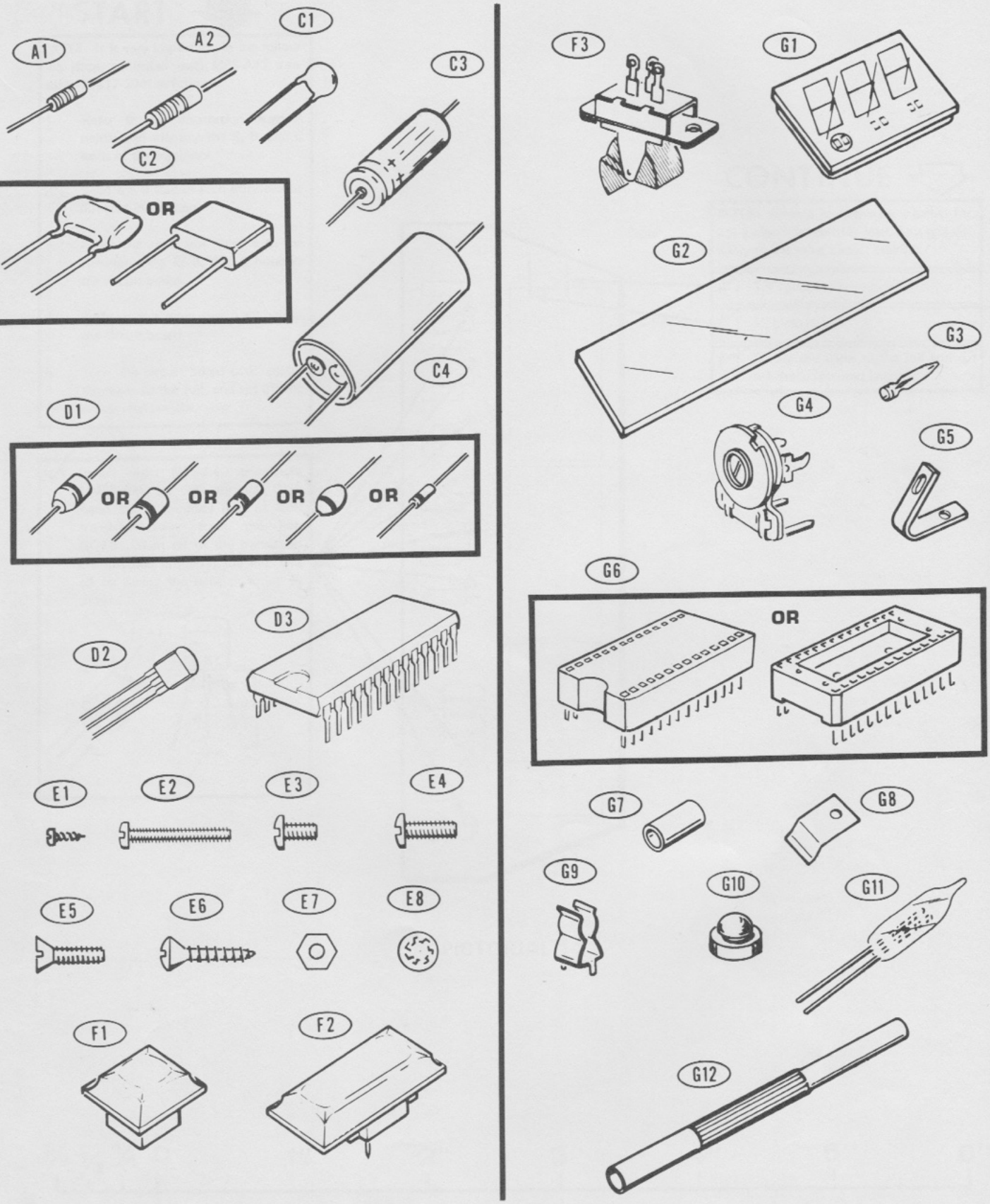
( ) Cut both leads of the 180 kΩ, 1/4-watt (brown-gray-yellow) resistor to 3/8". Push the resistor lead into each pin to enlarge the opening and make it easier to install the display tubes later. Reheat and straighten any pins that are not straight. This resistor will not be used for any other purpose.



PICTORIAL 1-1



PARTS PICTORIAL

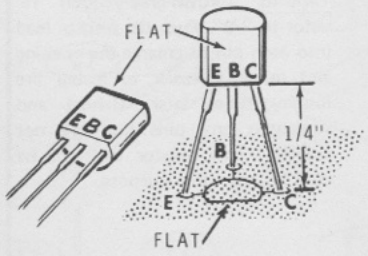


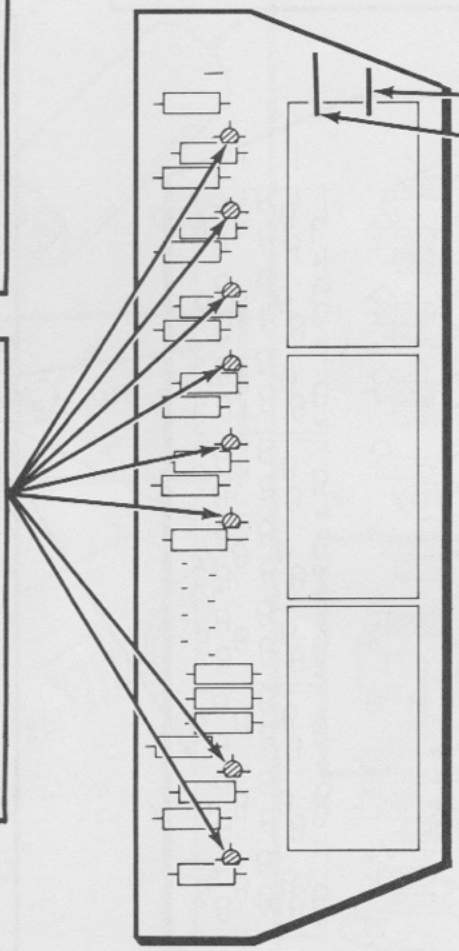
START

NOTE: It is very important, in the following steps, to install each MPS-A42 transistor (#417-294) as follows:

1. Refer to the illustration example below and identify the E, B, and C leads of the transistor.
2. Bend the B lead of each transistor as directed in the step.
3. Insert the transistor leads into the corresponding E, B, and C holes in the circuit board.
4. Position the transistor 1/4" above the circuit board.
5. Turn the circuit board over, solder the leads to the foil, and cut off the excess lead lengths.

(✓) Install eight MPS-A42 transistors (#417-294) at Q23 through Q30. Bend the B (middle) lead of each transistor away from the flat. NOTE: When all of the transistors are installed properly, the flats will all be facing the same direction as shown.





CONTINUE

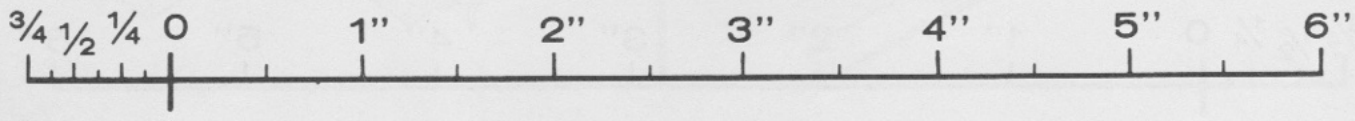
NOTE: When a jumper wire is called for, use a discarded resistor lead. This will also apply to the other circuit boards.

(✓) 3/4" jumper.

(✓) 1" jumper.

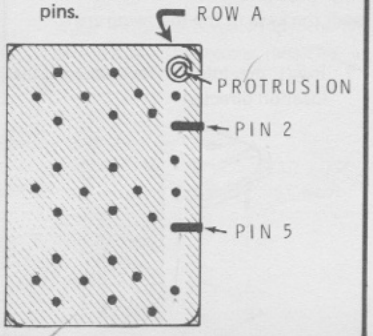
(✓) Solder the wires to the foil and cut off the excess lead lengths.

PICTORIAL 1-2

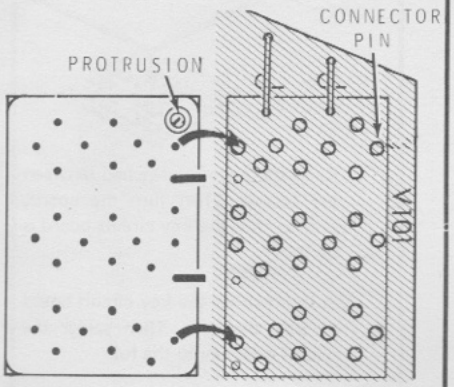


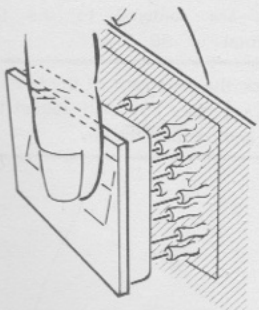
START

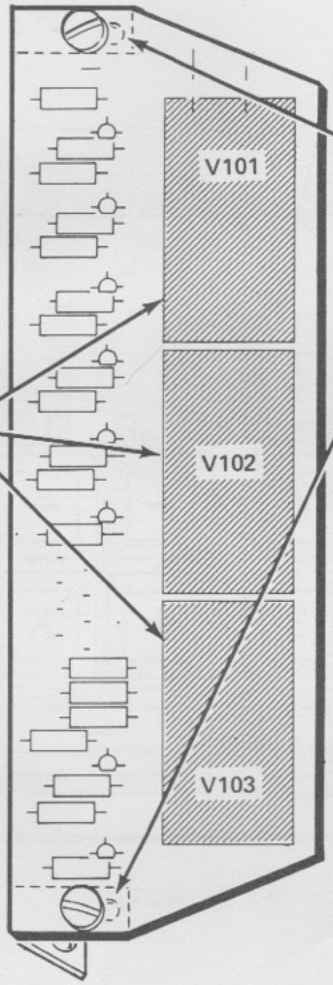
( ) Position the display tubes so the protrusion at the one corner is as shown. Bend pins 2 and 5 of row A down against the tube. Make sure these pins do not touch any other pins.



( ) Straighten any pins that might be bent, with the exception of the two previously bent down. Then install the tubes at V101, V102, and V103. As you install each tube, make sure each pin goes into a connector.



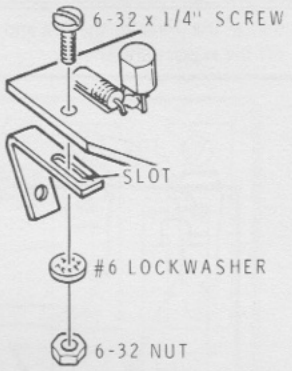




PICTORIAL 1-3

CONTINUE

( ) Mount the slotted side of the angle brackets to the foil side of the board with 6-32 x 1/4" screws, #6 lockwashers, and 6-32 nuts. Center the screws in the slots and tighten the hardware.



CIRCUIT BOARD CHECKOUT

It is important that the following check-out procedure be done after each circuit board is completed.

Visual Inspection

Carefully inspect the foil side of the circuit board for the following most commonly made errors. Consult your "Kit Builders Guide" to remedy these problems, if any exist.

( ) Unsoldered connections.

( ) "Cold" solder connections.

( ) Solder bridges between foil patterns.

( ) Protruding leads which could touch together.

( ) Check transistors for the proper type and installation. Refer to the Pictorial where the part was installed and check it against the installation instructions.

FINISH

START

KEEP YOUR SOLDERING IRON TIP CLEAN

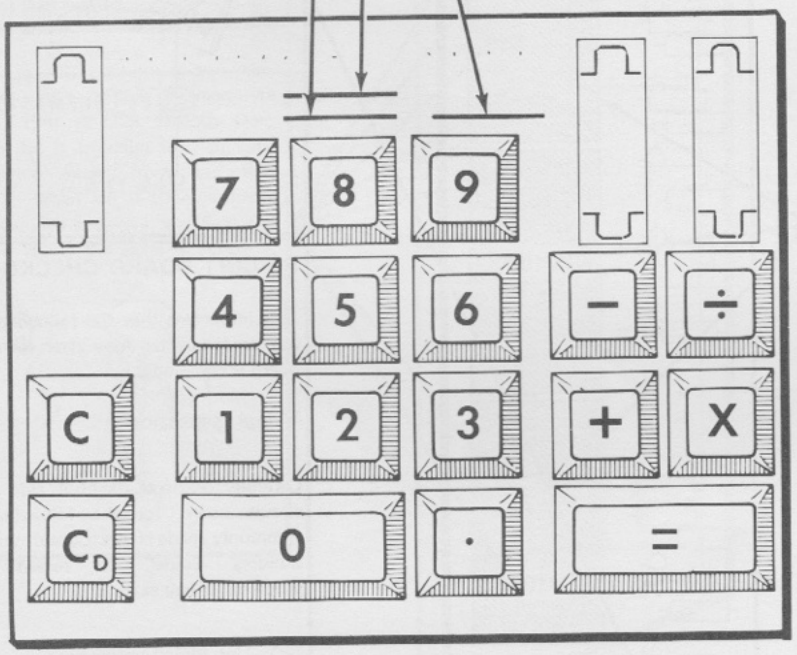
Position the key circuit board as shown.

(✓) 1-1/4" jumper.

(✓) 1-1/4" jumper.

(✓) 1-1/4" jumper.

(✓) Solder the wires to the foil and cut off the excess wire lengths.

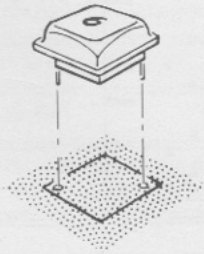


PICTORIAL 2-1

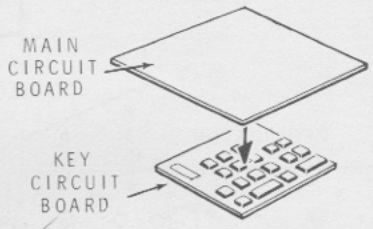
CONTINUE

Install the keys in the following steps.

(✓) Insert the lugs of each key at the location directed.



(✓) After all of the keys are installed on the key circuit board, carefully place the main circuit board on top of the keys. The main board is used only to hold the keys in place.

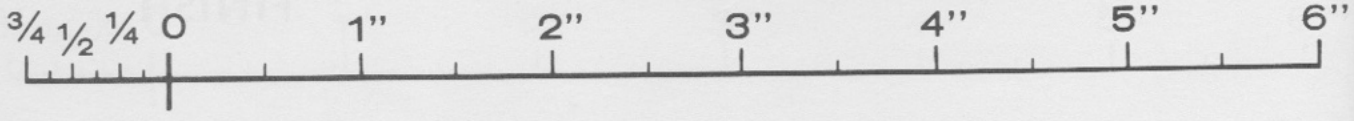


(✓) Keep the keys sandwiched between the boards. Then turn the boards over so that the key circuit board is on top.

(✓) Push down on the key circuit board to seat the keys. Then solder the lugs of each key to the foil.

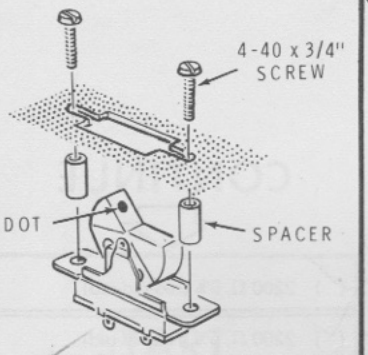
(✓) Make sure both lugs of each key are soldered to the foil, a total of 36 lugs.

(✓) Check the alignment of the keys. If any key does not align, reheat the lugs and position the key.



START

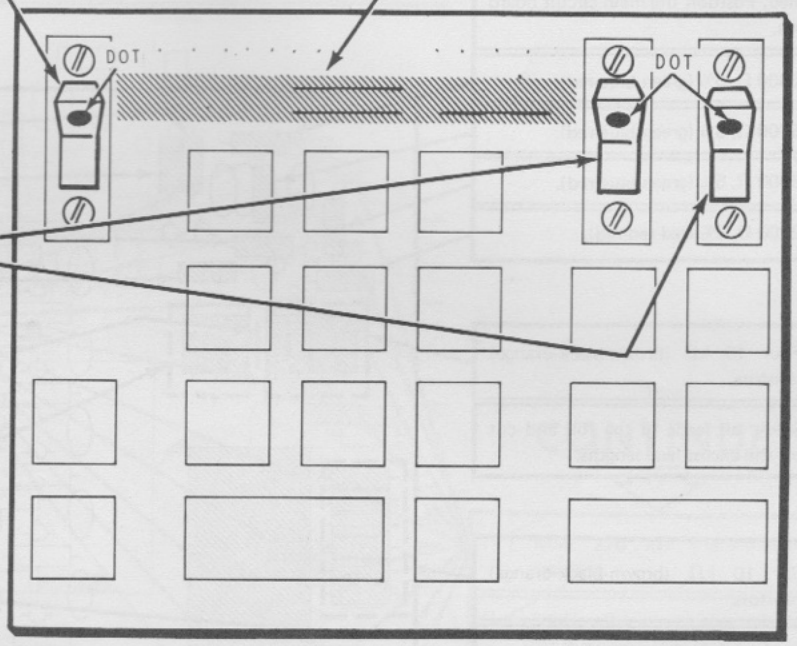
(✓) Rocker switch at SW-11. Position the switch with the dot as shown. Mount the switch with 4-40 x 3/4" black screws and metal spacers. Do not tighten the screws securely at this time.



(✓) Similarly mount rocker switches at SW-12 and SW-13.

CONTINUE

(✓) Peel away the backing from a 3" length of foam tape and install the tape over the jumper wires.



PICTORIAL 2-2

CIRCUIT BOARD CHECKOUT

Carefully inspect the circuit board for the following conditions.

(✓) Unsoldered connections.

(✓) "Cold" solder connections.

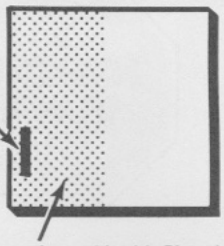
(✓) Solder bridges between foil patterns.

(✓) Protruding leads which could touch together.

FINISH

KEEP YOUR SOLDERING IRON TIP CLEAN

IDENTIFICATION DRAWING



The steps performed in this Pictorial are in this area of the circuit board.

START

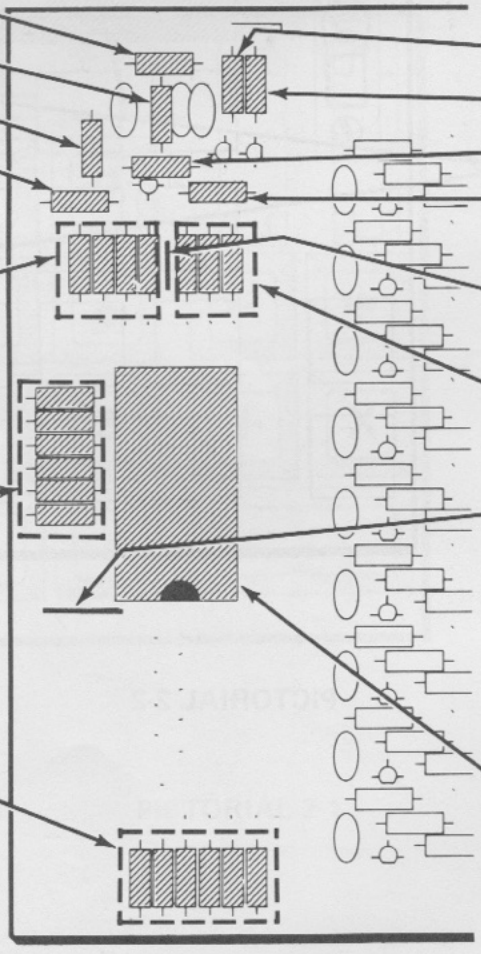
NOTE: Only a part of the main circuit board will be shown in the following Pictorials. Refer to the identification drawing at the top of each page. The shaded area in the identification drawing shows the area of the circuit board being assembled. Position the main circuit board as shown.

- (✓) 5600 Ω, 5% (green-blue-red).
- (✓) 5600 Ω, 5% (green-blue-red).
- (✓) 5600 Ω, 5% (green-blue-red).
- (✓) 2200 Ω, 5% (red-red-red).

- (✓) Four 10 kΩ (brown-black-orange) resistors.
- (✓) Solder all leads to the foil and cut off the excess lead lengths.

- (✓) Six 10 kΩ (brown-black-orange) resistors.
- (✓) Solder all leads to the foil and cut off the excess lead lengths.

- (✓) Six 10 kΩ (brown-black-orange) resistors.
- (✓) Solder all leads to the foil and cut off the excess lead lengths.



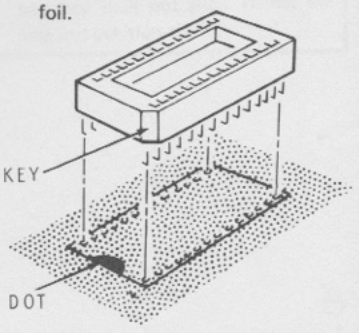
CONTINUE

- (✓) 2200 Ω, 5% (red-red-red).
- (✓) 2200 Ω, 5% (red-red-red).
- (✓) 5600 Ω, 5% (green-blue-red).
- (✓) 5600 Ω, 5% (green-blue-red).

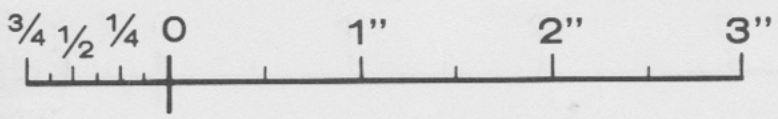
- (✓) 3/4" jumper.

- (✓) Three 10 kΩ (brown-black-orange).

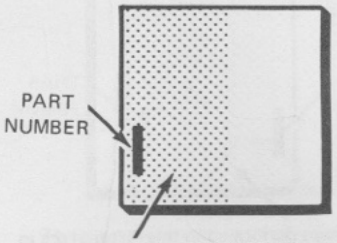
- (✓) 1" jumper.
- (✓) Solder all leads to the foil and cut off the excess lead lengths.
- (✓) IC socket. Be sure the leads are straight, position the notched or keyed end over the half dot on the circuit board, insert the leads into the holes, and solder the leads to the foil.



PICTORIAL 3-1



IDENTIFICATION DRAWING

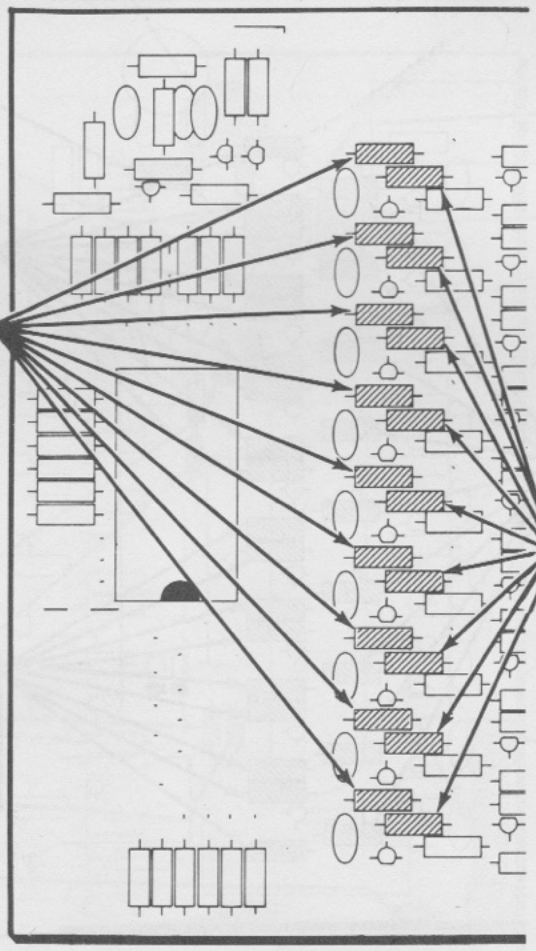


The steps performed in this Pictorial are in this area of the circuit board.

START

(✓) Nine 1 MΩ (brown-black-green) resistors.

(✓) Solder all leads to the foil and cut off the excess lead lengths.

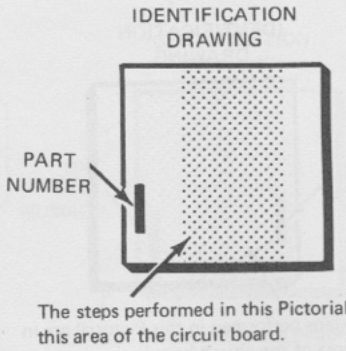


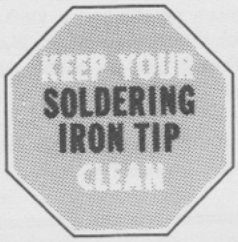
CONTINUE

(✓) Nine 270 kΩ (red-violet-yellow) resistors.

(✓) Solder all leads to the foil and cut off the excess lead lengths.

PICTORIAL 3-2





START

(✓) Nine 120 kΩ (brown-red-yellow) resistors.

(✓) Solder all leads to the foil and cut off the excess lead lengths.

CONTINUE

(✓) 68 kΩ (blue-gray-orange).

(✓) Nine 120 kΩ (brown-red-yellow) resistors.

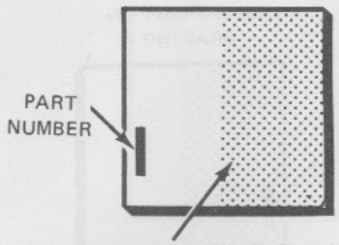
(✓) Solder all leads to the foil and cut off the excess lead lengths.

(✓) Nine 120 kΩ (brown-red-yellow) resistors.

(✓) Solder all leads to the foil and cut off the excess lead lengths.

PICTORIAL 3-3

IDENTIFICATION DRAWING

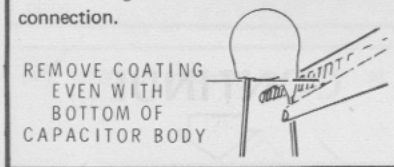


The steps performed in this Pictorial are in this area of the circuit board.

START

( ) 50 kΩ control (#10-392). Push the control against the board and solder the four lugs to the foil.

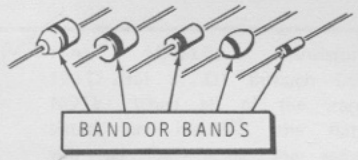
NOTE: Check the leads of each disc, or Mylar capacitor as you install it. Remove the coating from each capacitor as shown. This coating could cause a bad solder connection.



( ) .22 μF Mylar.

( ) .02 μF disc.

NOTE: DIODES MAY BE SUPPLIED IN ANY OF THE FOLLOWING SHAPES. ALWAYS POSITION THE BANDED END AS SHOWN ON THE CIRCUIT BOARD.



( ) 1N2071 silicon diode (#57-27) at D1.

( ) 1N2071 silicon diode (#57-27) at D5.

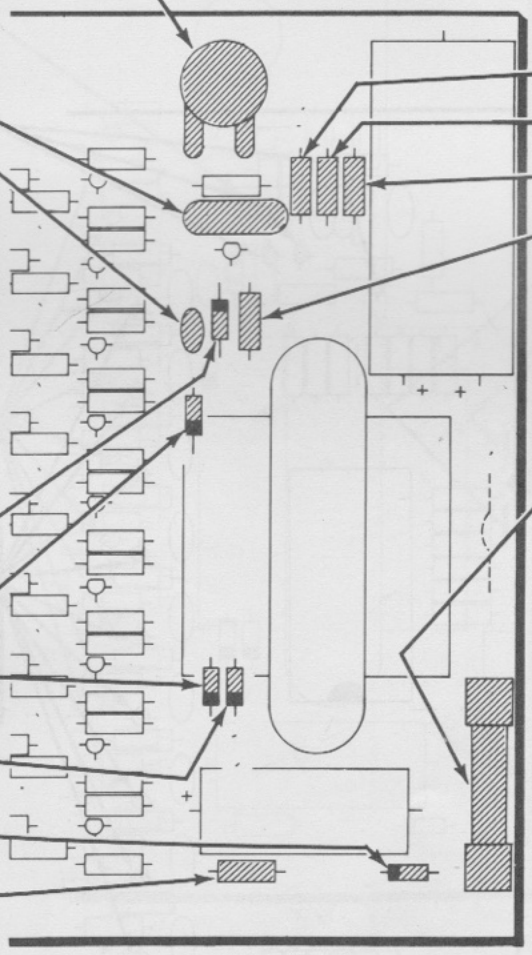
( ) 1N3017 zener diode (#56-97) at D3.

( ) 1N4002 silicon diode (#57-65) at D2.

( ) 1N3017 zener diode (#56-97) at D4.

( ) 68 Ω, 5% (blue-gray-black).

( ) Solder all leads to the foil and cut off the excess lead lengths.



CONTINUE

( ) 5600 Ω, 5% (green-blue-red).

( ) 10 kΩ (brown-black-orange).

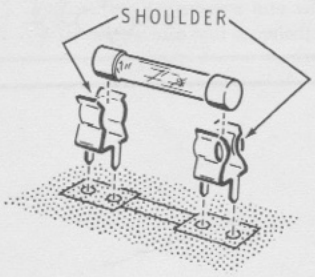
( ) 18 kΩ (brown-gray-orange).

( ) 120 kΩ (brown-red-yellow).

( ) Solder all leads to the foil and cut off the excess lead lengths.

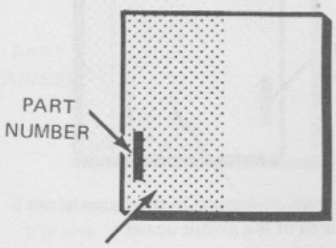
( ) First install the fuse clips in the circuit board. Be sure to position the fuse clip shoulders as shown. Do not solder the clips to the foil.

( ) Install a 1/8-ampere fuse into the fuse clips; then solder the fuse clip lugs to the foil.



PICTORIAL 3-4

IDENTIFICATION DRAWING

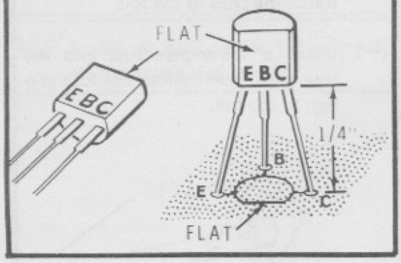


The steps performed in this Pictorial are in this area of the circuit board.

START

NOTE: In the following steps, install each of the transistors as follows:

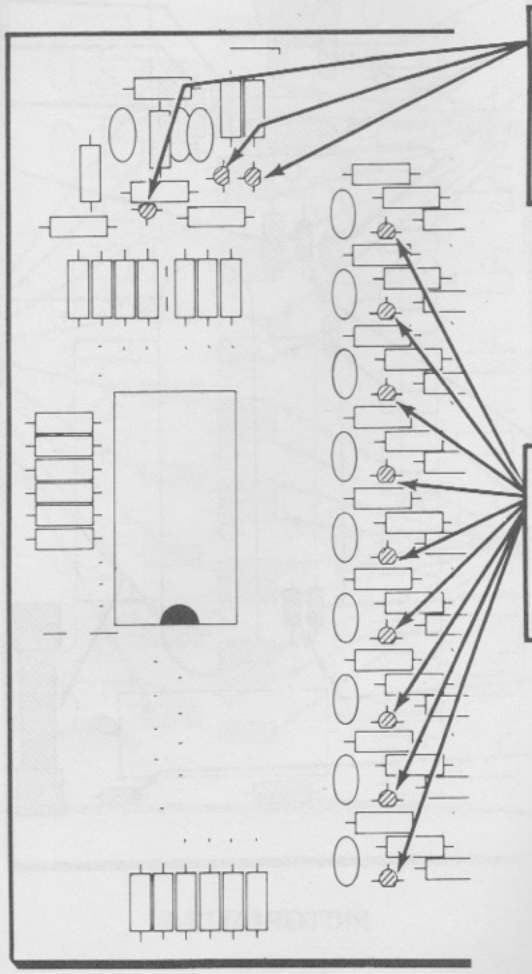
1. Refer to the illustration example below and identify the E, B, and C leads of the transistor.
2. Bend the B lead of each transistor away from the flat.
3. Insert the transistor leads into the corresponding E, B, and C holes in the circuit board.
4. Position the transistor 1/4" above the circuit board.
5. Turn the circuit board over, solder the leads to the foil, and cut off the excess lead lengths.



CONTINUE

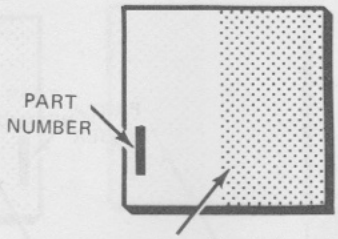
(✓) Three MPS-A20 transistors (#417-801) at Q19, Q20, and Q21. NOTE: When these transistors are installed, the flats will face the same direction as screened on the circuit board.

( ) Nine MPS-A20 transistors (#417-801) at Q10 through Q18. NOTE: When all of these transistors are installed, the flats will all be facing the same direction as screened on the circuit board.



PICTORIAL 3-5

IDENTIFICATION DRAWING

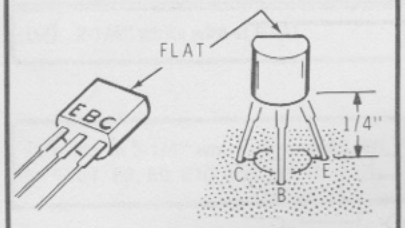


The steps performed in this Pictorial are in this area of the circuit board.

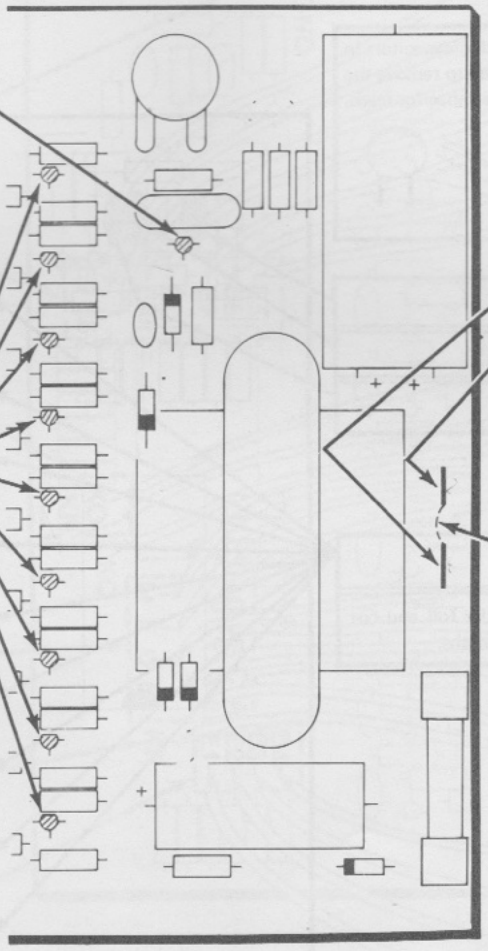
START

NOTE: In the following steps, be sure to install the correct transistor at the correct place.

(✓) MPS-A42 transistor (#417-294) at Q22.



(✓) Nine MPS-L51 transistors (#417-295) at Q1 through Q9. NOTE: When all of the transistors are installed, the flats will all be facing the same direction as screened on the circuit board.



CONTINUE

ALTERNATE LINE VOLTAGE WIRING

Two sets of line voltage wiring instructions are given, one for 120 VAC line voltage and the other for 240 VAC line voltage. In the U.S.A., 120 VAC is most often used, while in foreign countries 240 VAC is more common. USE ONLY THE INSTRUCTIONS THAT AGREE WITH THE LINE VOLTAGE IN YOUR AREA.

120 VAC Wiring

(✓) 3/4" jumper.

(✓) 3/4" jumper.

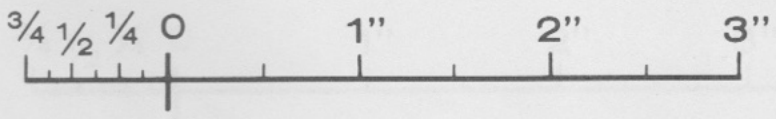
(✓) Solder the wires to the foil and cut off the excess wire lengths.

240 VAC Wiring

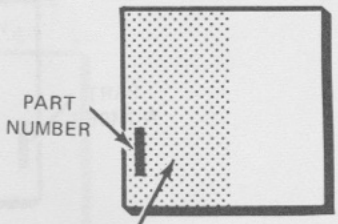
( ) 3/4" jumper. Solder the wire to the foil and cut off the excess wire length.

NOTE: For 240 VAC operation, replace the 1/8-ampere fuse with a 1/16-ampere fuse (not supplied).

PICTORIAL 3-6

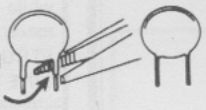


IDENTIFICATION DRAWING



The steps performed in this Pictorial are in this area of the circuit board.

NOTE: Before installing disc capacitors in this kit, use long-nose pliers to remove the excess insulation from the capacitor leads.



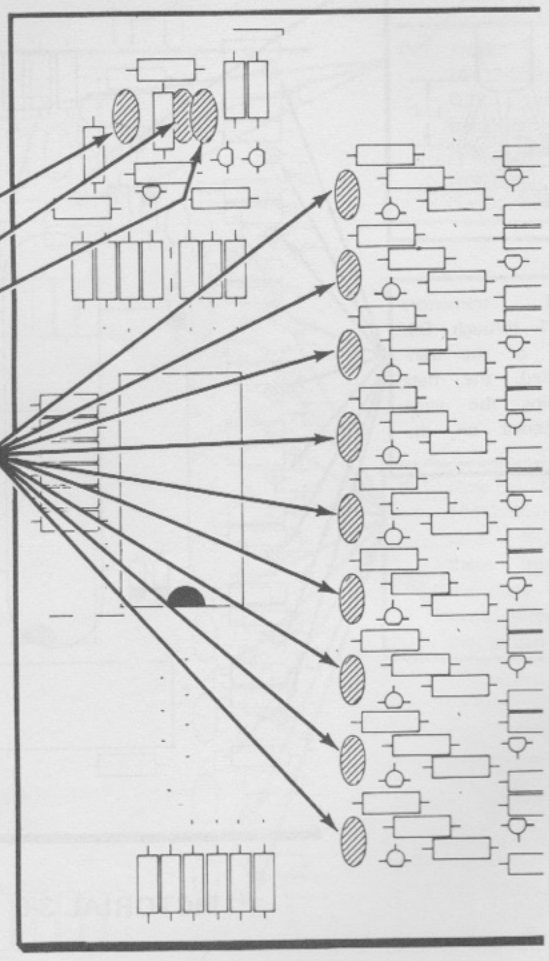
(✓) .001 μF disc.

(✓) 680 pF disc.

(✓) 680 pF disc.

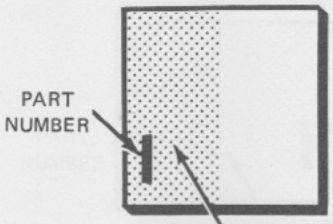
(✓) Nine .001 μF disc.

(✓) Solder all leads to the foil and cut off the excess lead lengths.



PICTORIAL 3-7

IDENTIFICATION DRAWING



The steps performed in this Pictorial are in this area of the circuit board.

START

NOTE: To prepare the wires in the following steps, cut them to the lengths specified and remove 1/4" of insulation from each end. When several wires of the same length are called for, as in the second step, you may want to prepare all the wires first. As you install each wire, solder it to the foil and cut off the excess wire end. The free ends of the wires will be connected later.

( ) 2-1/4" white wire at GND.

( ) Seven 3-1/4" white wires at E5, E6, E7, E8, E9, E10, and E11.

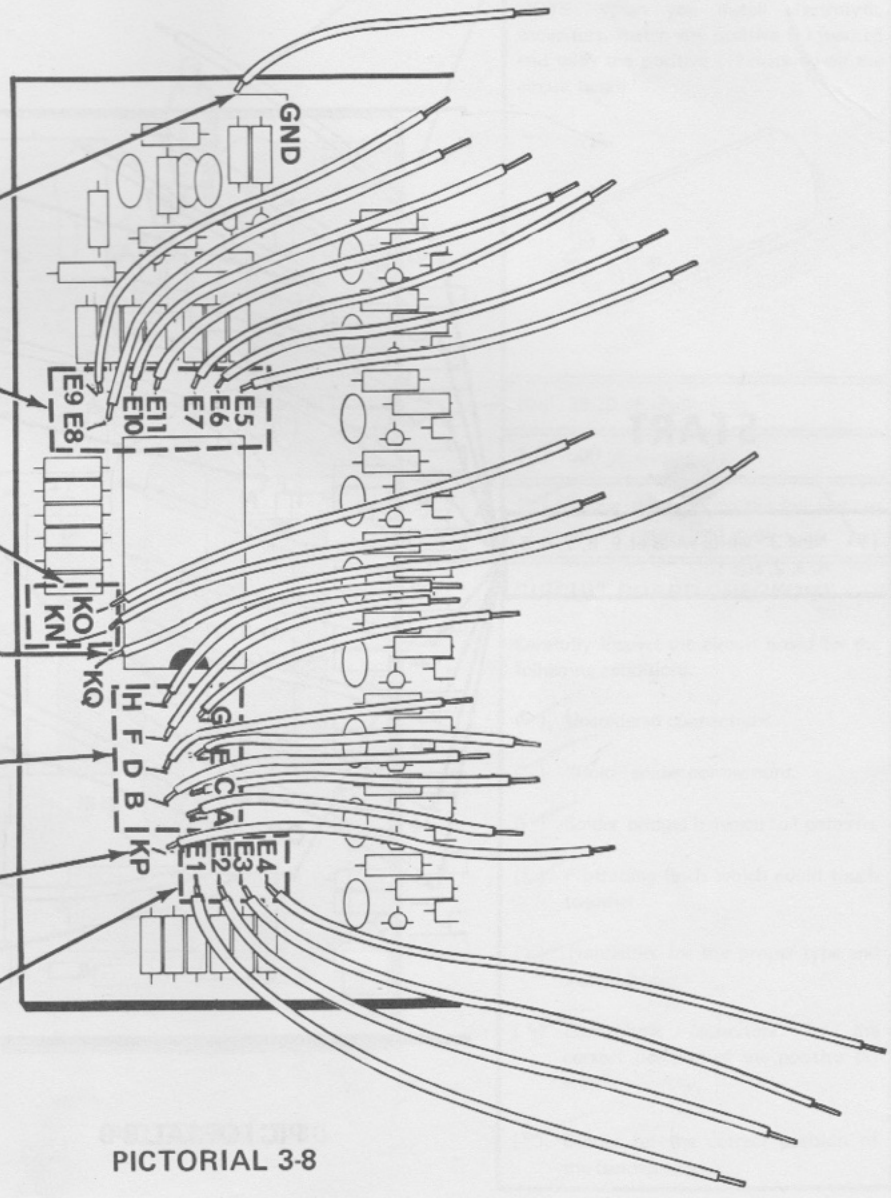
( ) Two 3-1/2" white wires at KN and KO.

( ) 4-1/2" white wire at KQ.

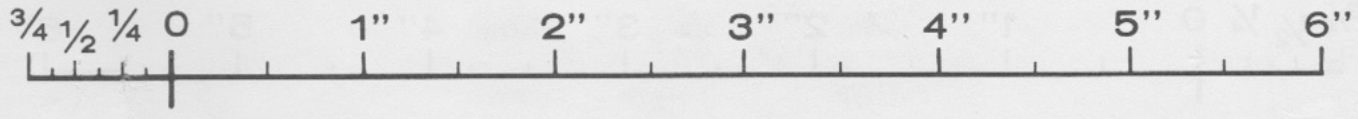
( ) Eight 2-1/4" white wires at A, B, C, D, E, F, G, and H.

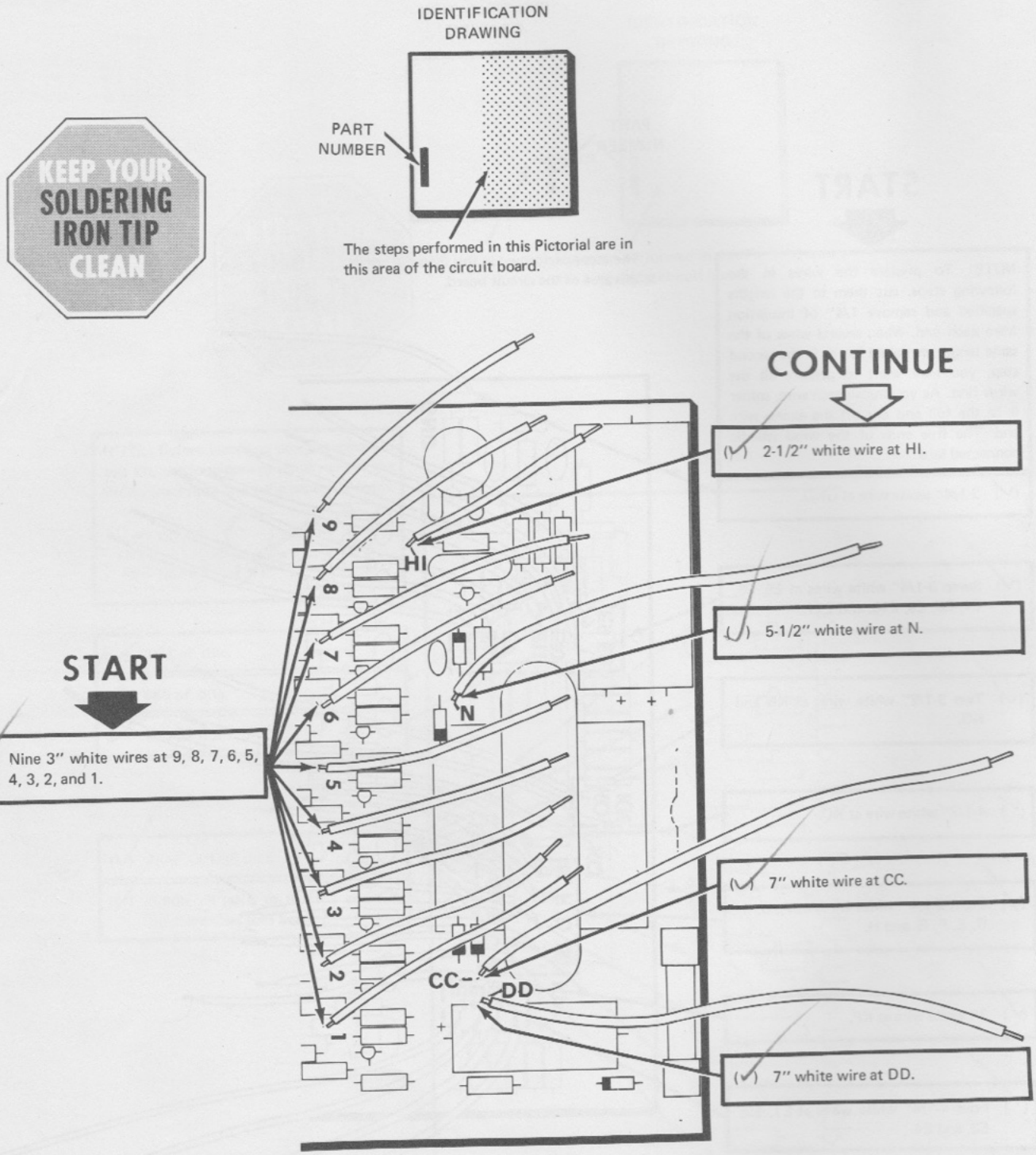
( ) 3" white wire at KP.

( ) Four 4-1/4" white wires at E1, E2, E3, and E4.

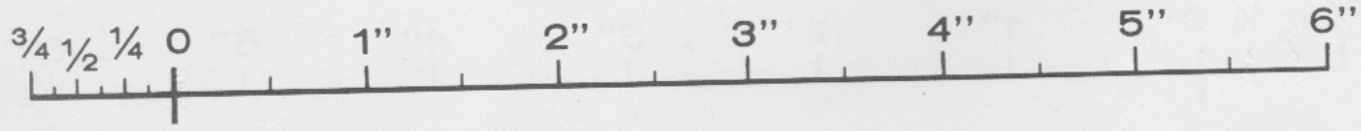


PICTORIAL 3-8

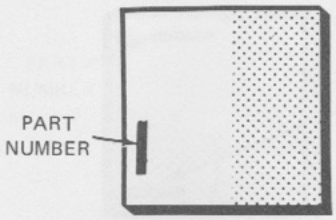




PICTORIAL 3-9



IDENTIFICATION DRAWING

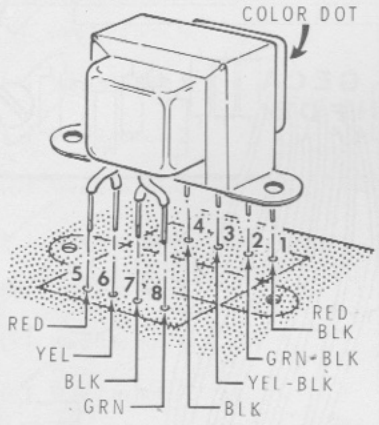


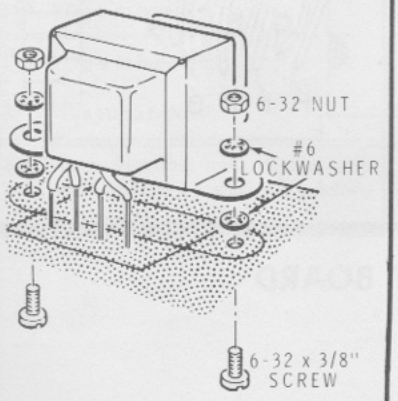
The steps performed in this Pictorial are in this area of the circuit board.

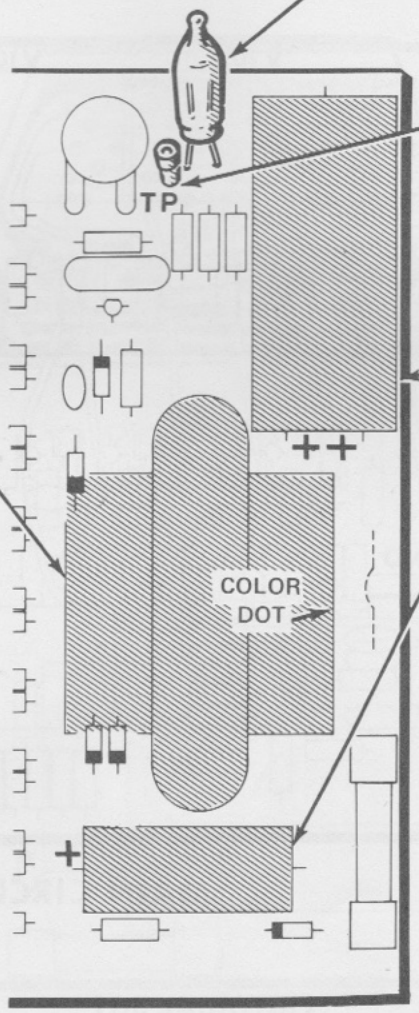
START

( ) Position the power transformer so the color dot on one side is on your right. Then insert the leads in holes 1 through 8. Make sure the bare part of each lead is all the way into the hole. Then fasten the transformer with two 6-32 x 3/8" screws, four #6 lockwashers and two 6-32 nuts.

(✓) Make sure each lead is in its correct hole. Then solder the leads to the foil, and cut off the excess lead length.







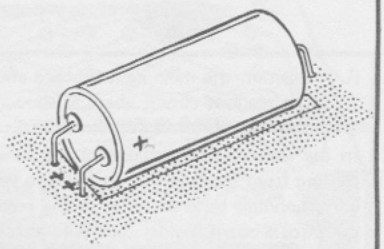
PICTORIAL 3-10

CONTINUE

(✓) Neon lamp at V1. Position the lamp 1/4" above the circuit board. Solder the leads to the foil and cut off the excess lead lengths.

(✓) Connector pin at TP. Solder the pin to the foil.

NOTE: When you install electrolytic capacitors, match the positive (+) marked end with the positive (+) marking on the circuit board.



(✓) 20-20 μF electrolytic.

(✓) 500 μF electrolytic.

(✓) Solder the leads to the foil and cut off the excess lead lengths.

CIRCUIT BOARD CHECKOUT

Carefully inspect the circuit board for the following conditions.

(✓) Unsoldered connections.

(✓) "Cold" solder connections.

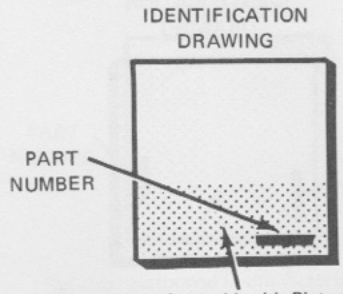
(✓) Solder bridges between foil patterns.

(✓) Protruding leads which could touch together.

(✓) Transistors for the proper type and installation.

(✓) Electrolytic capacitors for the correct position of the positive (+) end.

(✓) Diodes for the correct position of the banded end.



The steps performed in this Pictorial are in this area of the circuit board.

START

(✓) Position the main circuit board and the readout circuit board as shown.

In the following steps, connect the wires coming from the main circuit board to the corresponding lettered holes in the readout circuit board. Solder each wire as it is connected and cut off the excess wire lengths. Position the other main circuit board wires away from the readout circuit board.

(✓) Wire GND to hole GND.

(✓) Wire H to hole H.

(✓) Wire F to hole F.

(✓) Wire D to hole D.

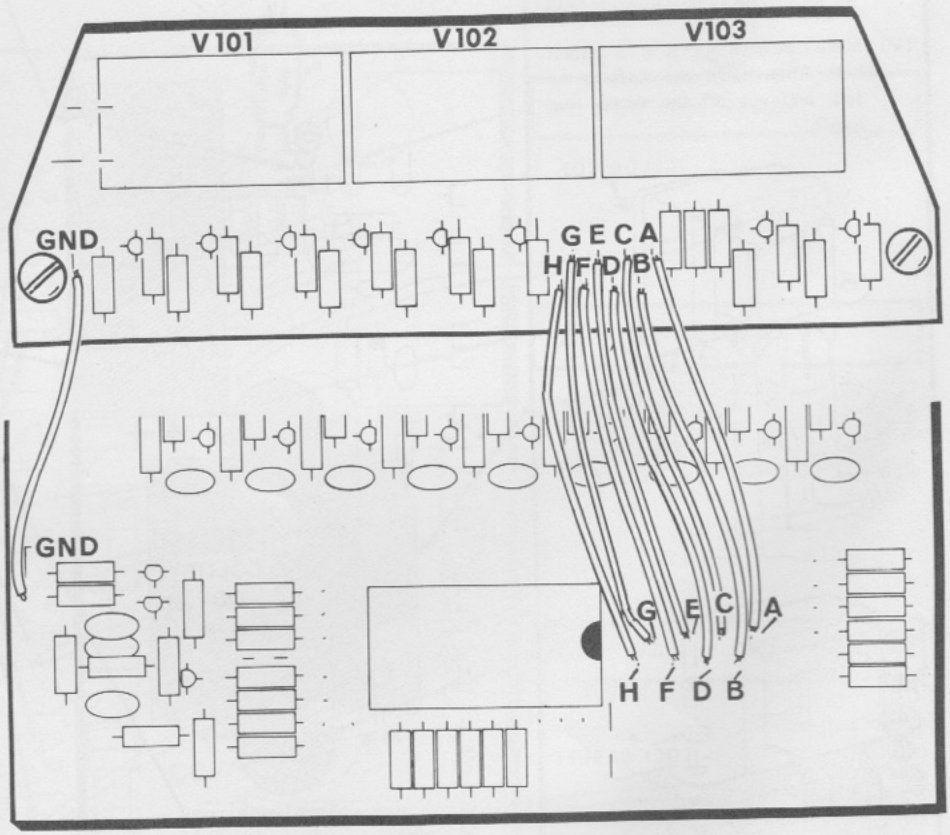
(✓) Wire B to hole B.

(✓) Wire A to hole A.

(✓) Wire C to hole C.

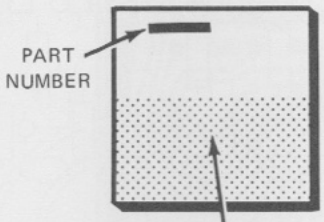
(✓) Wire E to hole E.

(✓) Wire G to hole G.



PICTORIAL 3-11

IDENTIFICATION DRAWING

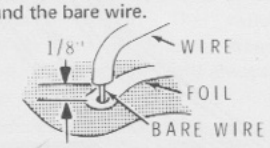


The steps performed in this Pictorial are in this area of the circuit board.

START

( ) Turn the main circuit board around so the power transformer is toward you.

NOTE: When you connect the following wires to the foil side of the readout circuit board, leave the insulation 1/8" away from the foil so that solder can flow around the bare wire.



( ) Wire N to hole N.

( ) Wire 1 to hole 1.

( ) Wire 2 to hole 2.

( ) Wire 3 to hole 3.

( ) Wire 4 to hole 4.

( ) Wire 5 to hole 5.

( ) Wire 6 to hole 6.

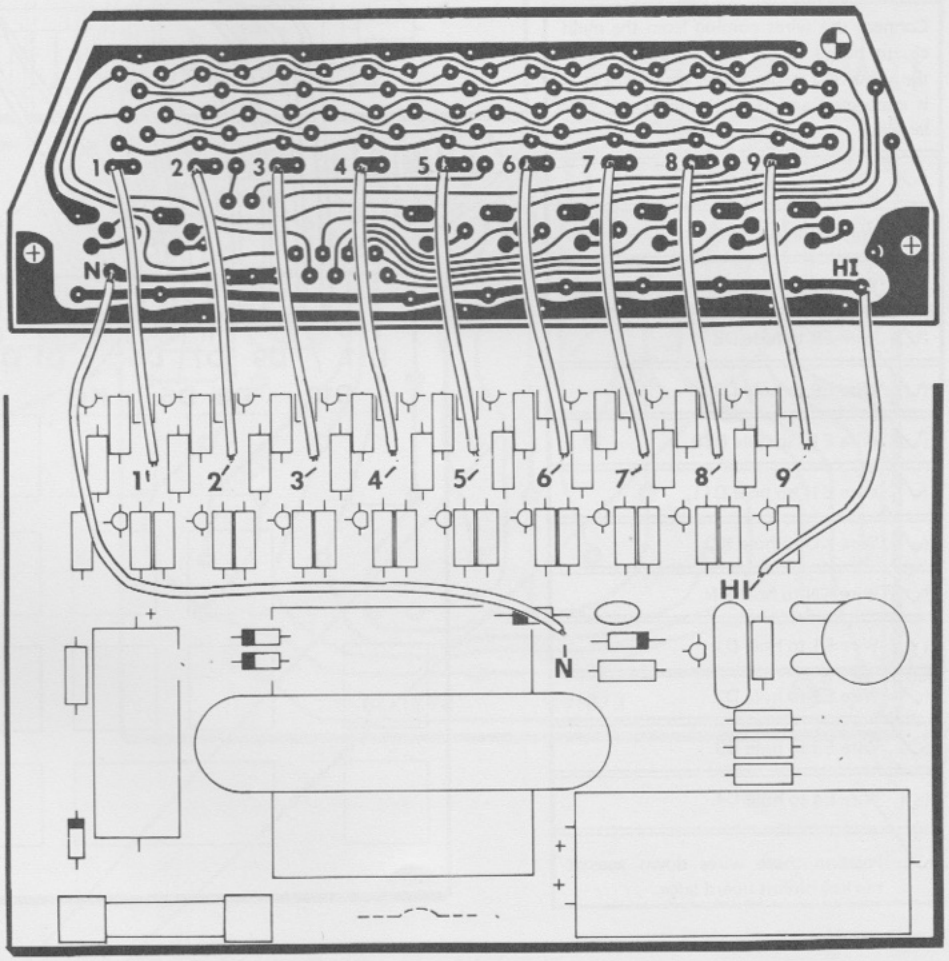
( ) Wire 7 to hole 7.

( ) Wire 8 to hole 8.

( ) Wire 9 to hole 9.

( ) Wire HI to hole HI.

( ) Make sure that none of the wires that you just installed are touching any readout tube pins.



PICTORIAL 3-12

START

( ) Position the main circuit board as shown and place the key circuit board in front of it.

Connect the wires coming from the main circuit board to the key circuit board in the following steps. Solder each wire as it is connected and cut off the excess wire lengths.

(✓) Wire E5 to hole D5.

(✓) Wire E6 to hole D6.

(✓) Wire E7 to hole D7.

(✓) Wire E8 to hole D8.

(✓) Wire E9 to hole D9.

(✓) Wire E10 to hole D10.

(✓) Wire E11 to hole D11.

(✓) Wire KO to hole KO.

(✓) Wire KN to hole KN.

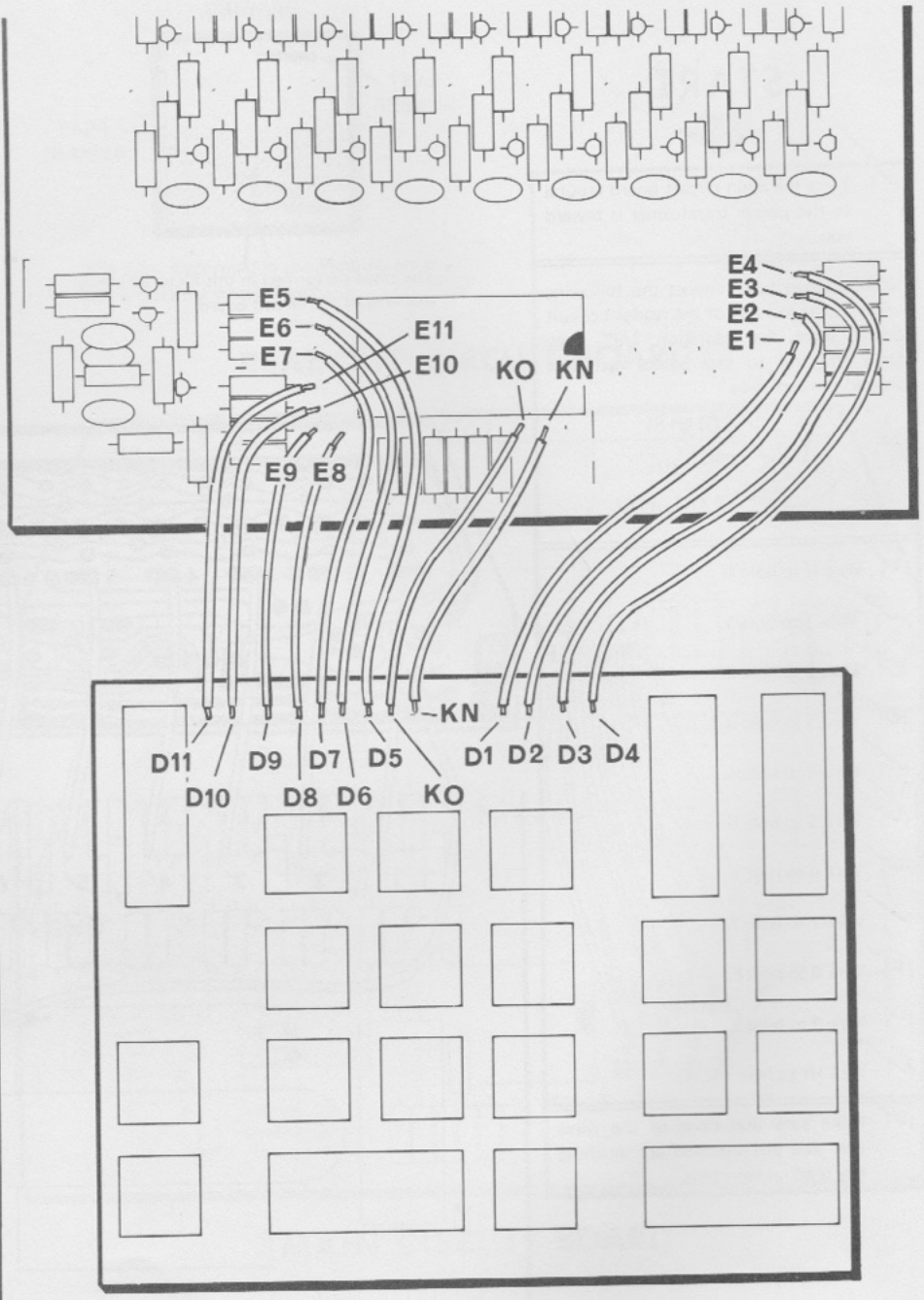
(✓) Wire E1 to hole D1.

(✓) Wire E2 to hole D2.

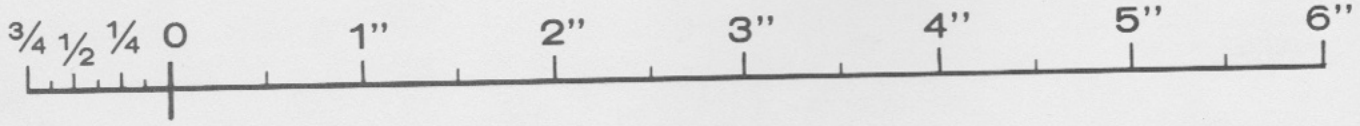
(✓) Wire E3 to hole D3.

(✓) Wire E4 to hole D4.

(✓) Position these wires down against the key circuit board edge.



PICTORIAL 3-13



START

( ) Turn the circuit boards over and position them as shown.

Solder the following wires as they are connected. NOTE: The switch lug positions may be different from those shown. However, lug 2 will always be the center lug.

( ) Connect the wire coming from CC on the main board to lug 3 of switch SW13.

( ) Connect the wire coming from DD on the main board to lug 2 of switch SW13.

( ) Connect the wire coming from KP to lug 2 of switch SW12.

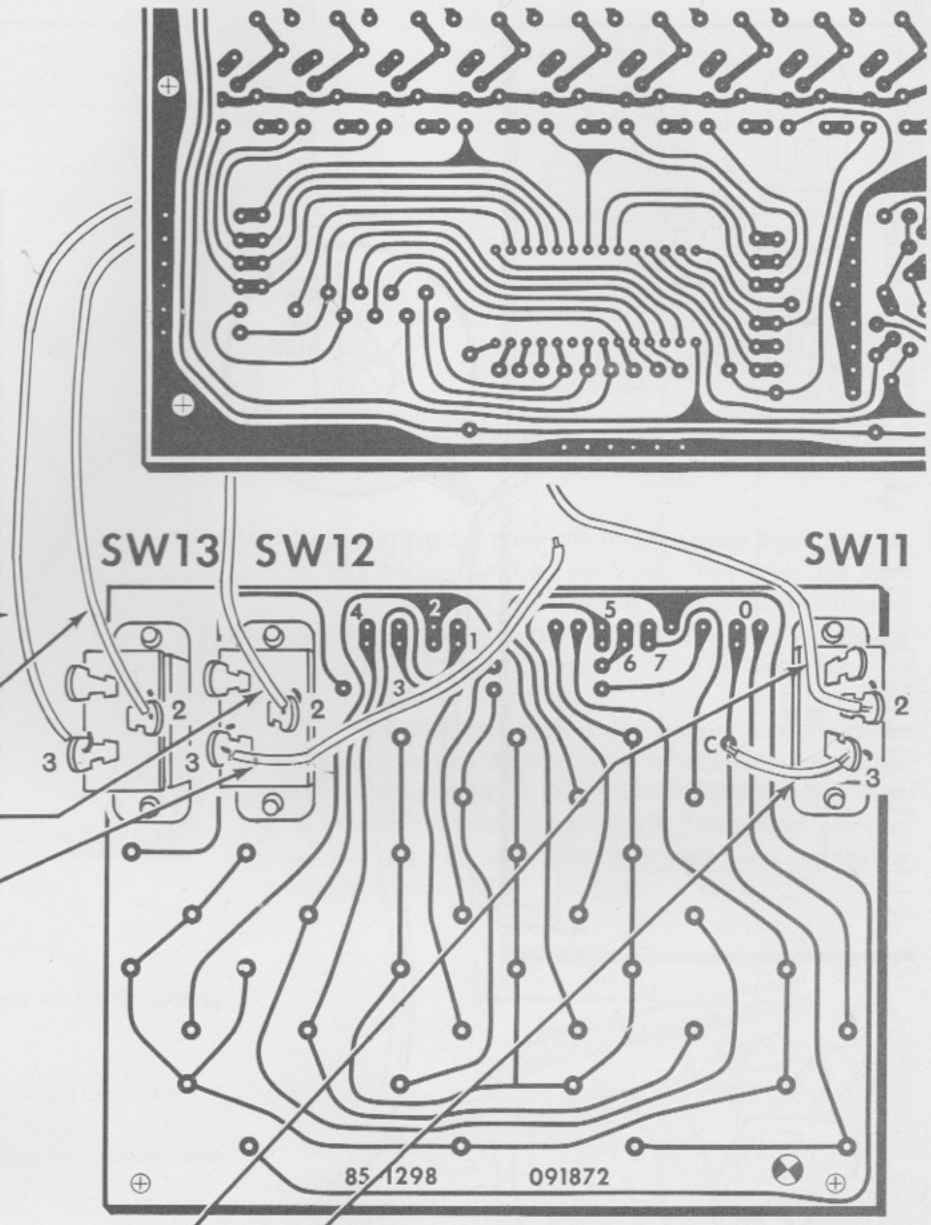
( ) Connect one end of a 4" white wire to lug 3 of switch SW12. The other end of this wire will be connected in the next step.

( ) There are holes on the foil side of the circuit board that are numbered 0 through 7. These holes indicate the fixed decimal point position. If you know where you want the fixed decimal to be positioned, for example in the second place, then solder the wire to hole 2. If you do not know at this time where you want the decimal point to be positioned, solder the wire to hole 0. Refer to Page 21 in the "Operation Manual" for more information on fixed Decimal operation.

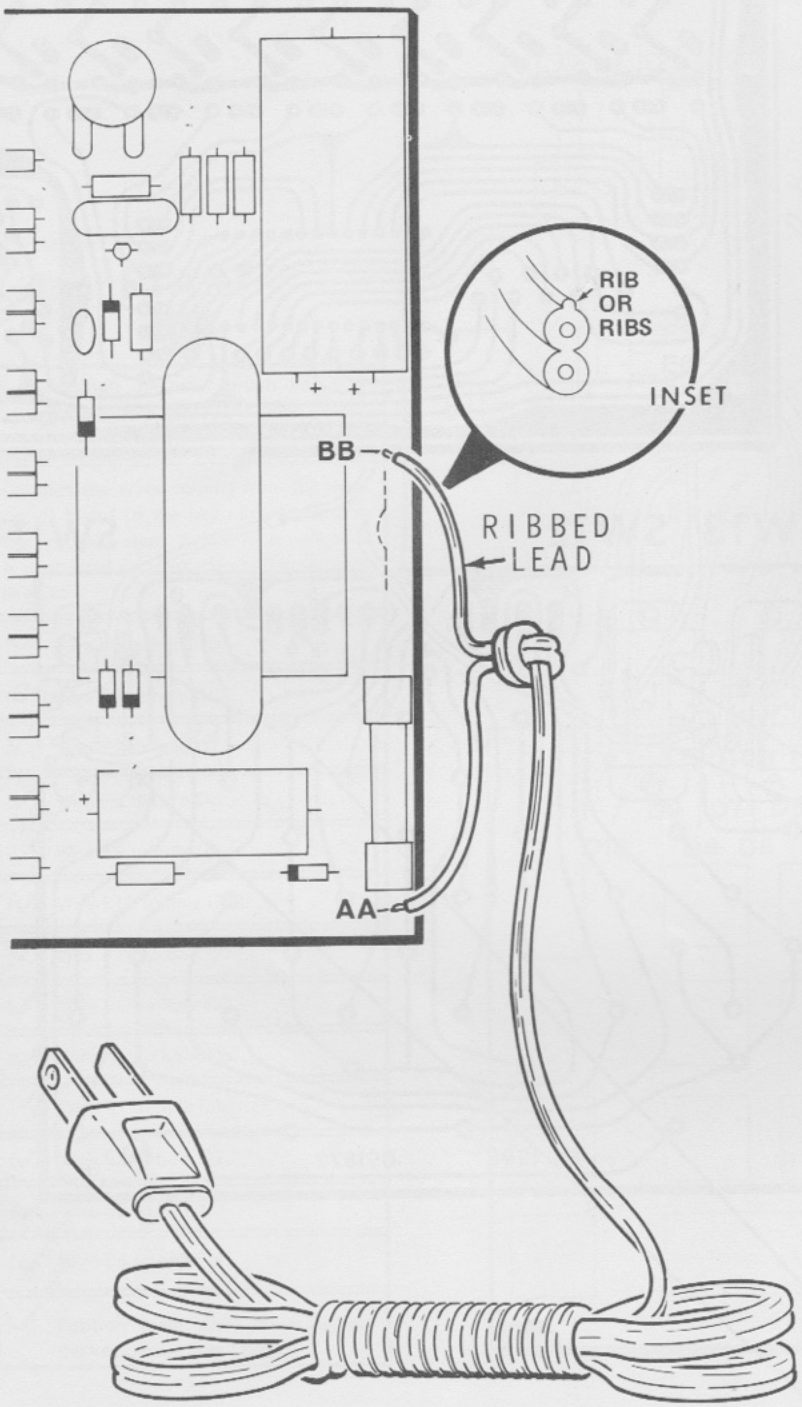
( ) Connect the wire coming from KQ on the main board to lug 2 of switch SW11.

( ) Connect a 1-1/2" white wire from lug 3 of switch SW11 to hole C.

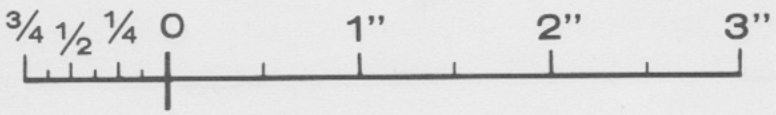
( ) Cut off the excess lead lengths.



PICTORIAL 3-14



PICTORIAL 3-15



START

( ) Position the main circuit board as shown.

( ) Separate the leads of the line cord for approximately 3" and tie a knot in the cord at this location.

( ) Prepare the ends of each lead by twisting the strands of wire together and applying a small amount of solder.

( ) Connect the ribbed lead of the cord to hole BB and the smooth lead to hole AA. Solder both connections and cut off the excess leads.

CIRCUIT BOARD CHECKOUT

Carefully inspect the circuit board for the following conditions.

( ) Unsoldered connections.

( ) "Cold" solder connections.

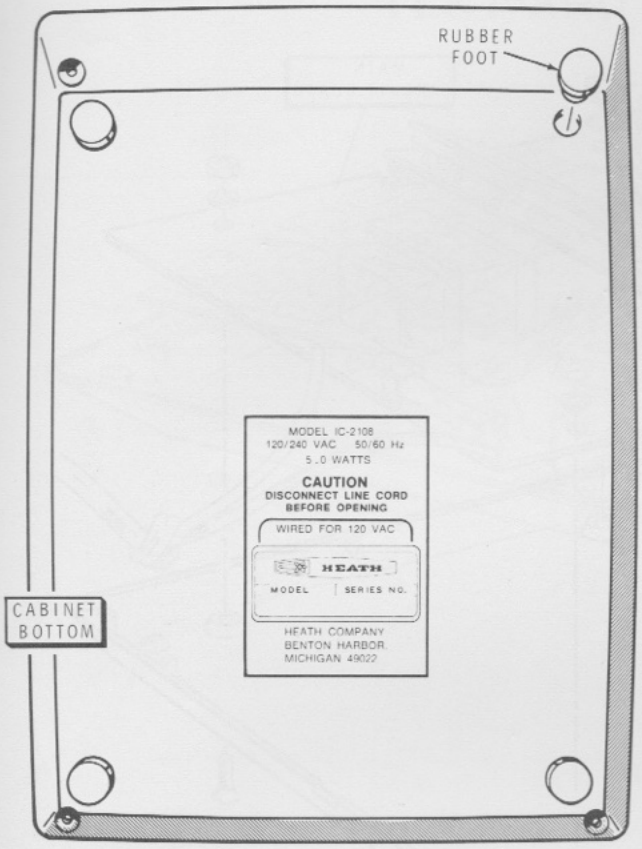
( ) Solder bridges between foil patterns.

( ) Protruding leads which could touch together.

( ) Transistors for the proper type and installation.

( ) Electrolytic capacitors for the correct position of the positive (+) end.

( ) Diodes for the correct position of the banded end.



PICTORIAL 4-1

Refer to Pictorial 4-1 and perform each of the following steps.

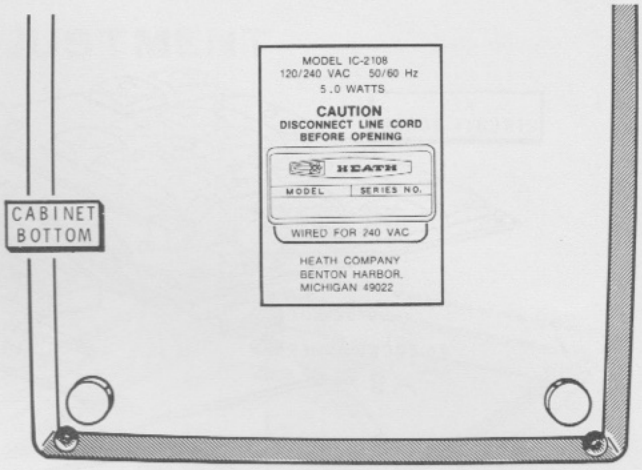
( ) Position the cabinet bottom upside down as shown.

( ) Insert a rubber foot at each corner by pushing and twisting the foot.

( ) Remove the backing paper from the power requirements label and install it on the cabinet bottom as shown.

NOTE: If the transformer was wired for 120 VAC operation, perform the following step. If the transformer was wired for 240 VAC operation, disregard the following step.

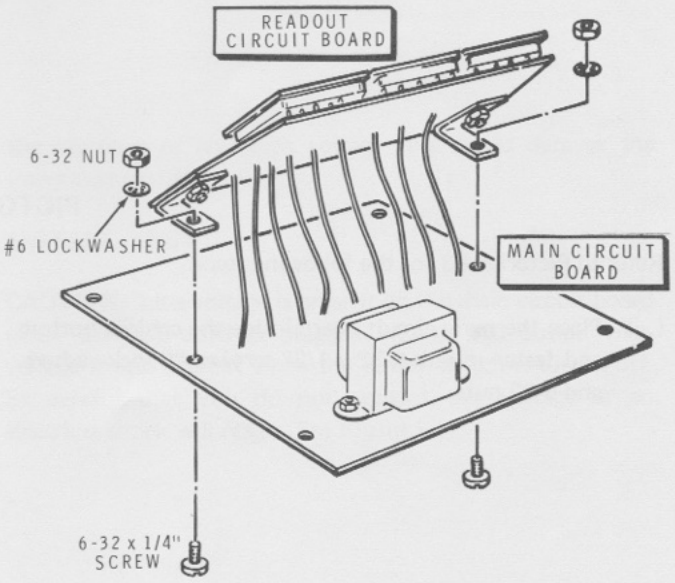
( ) Carefully peel away the backing paper from the blue and white identification label. Then press the label onto the power requirements label as shown in the Pictorial. Be sure to position the label over "Wired for 240 VAC" - leave "Wired for 120 VAC" exposed. Disregard the following step.



Detail 4-1A

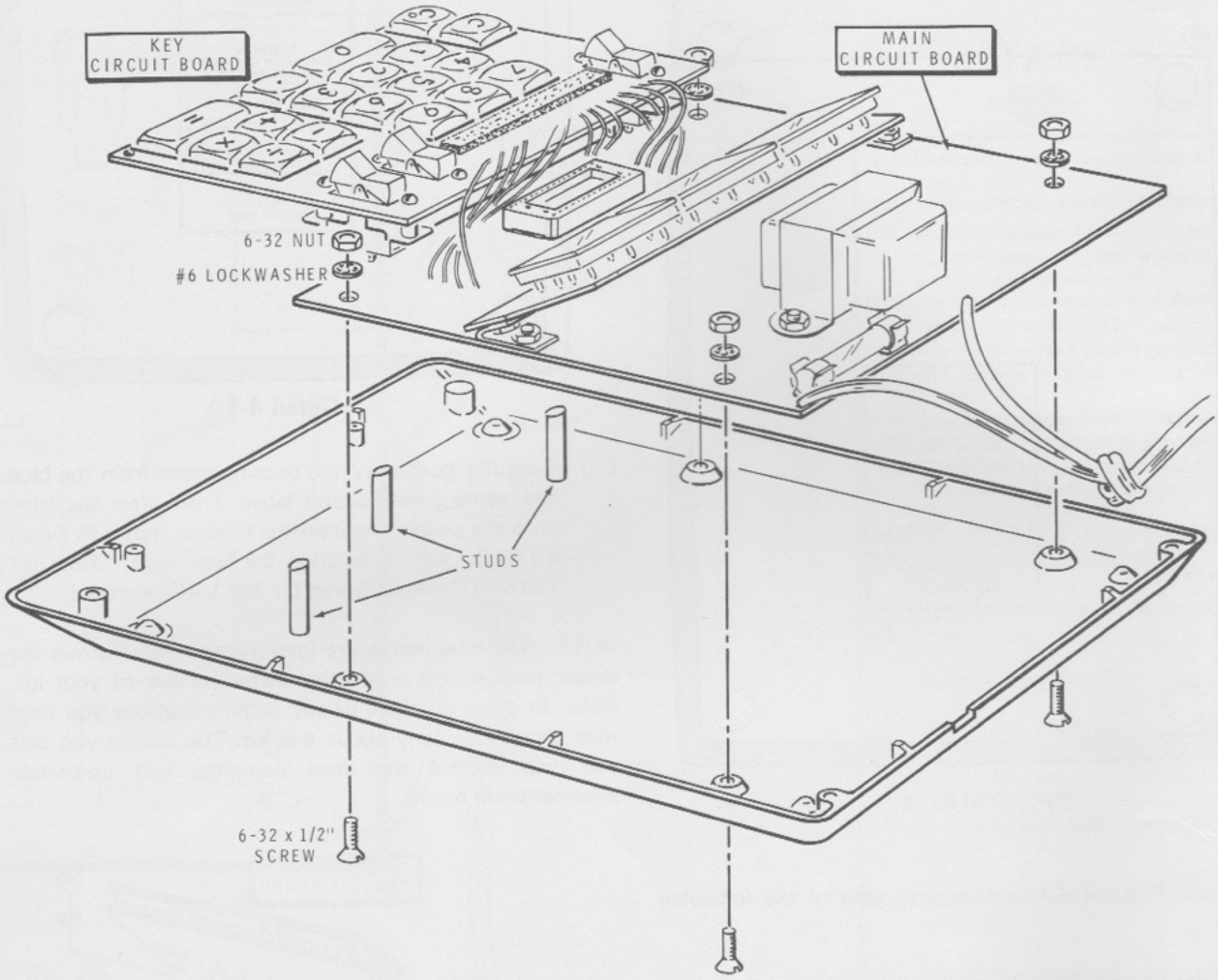
( ) Carefully peel away the backing paper from the blue and white identification label. Then press the label onto the power requirements label as shown in Detail 4-1A. Be sure to position the label over "Wired for 120 VAC" - leave "wired for 240 VAC" exposed.

NOTE: The blue and white identification label shows the model number and production series number of your kit. Refer to these numbers in any communications you have with Heath Company about this kit. This assures you that you will receive the most complete and up-to-date information in return.



PICTORIAL 4-2

( ) Refer to Pictorial 4-2 and mount the readout circuit board to the main circuit board with 6-32 x 1/4" screws, #6 lockwashers, and 6-32 nuts.



PICTORIAL 4-3

Refer to Pictorial 4-3 for the following steps.

( ) Place the main circuit board inside the cabinet bottom and fasten it with 6-32 x 1/2" screws, #6 lockwashers, and 6-32 nuts.

( ) Position the key circuit board as shown. It will be mounted later.

This completes the wiring of your Calculator. Proceed to "Test and Adjustment."

TEST AND ADJUSTMENT

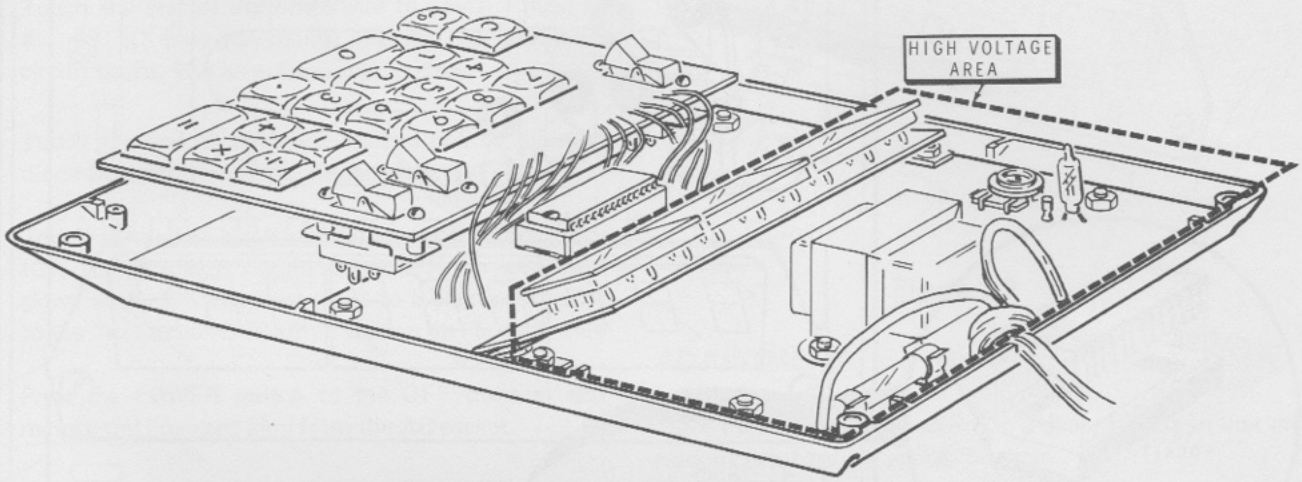


Figure 1-1

The purpose of the "Test" section of the Manual is to make sure your Calculator operates properly and will not be damaged as a result of a wiring error. A transistor or integrated circuit, for example, could be destroyed instantly by a short circuit that causes excessive current.

You will use a built-in tester in the following steps to check for the presence of high voltage. Three voltages of the power supply will be checked (130 VDC, 140 VDC, and 165 VDC). Also, each connector of the IC socket will be checked for the presence of any high voltage that could damage the integrated circuit.

INITIAL TEST

CAUTION: Line voltage is present on the main circuit board when the line cord is plugged into an AC outlet. High voltage is also present when the Power switch is turned off. Be careful that you do not contact this voltage or an electrical shock will result. See Figure 1-1.

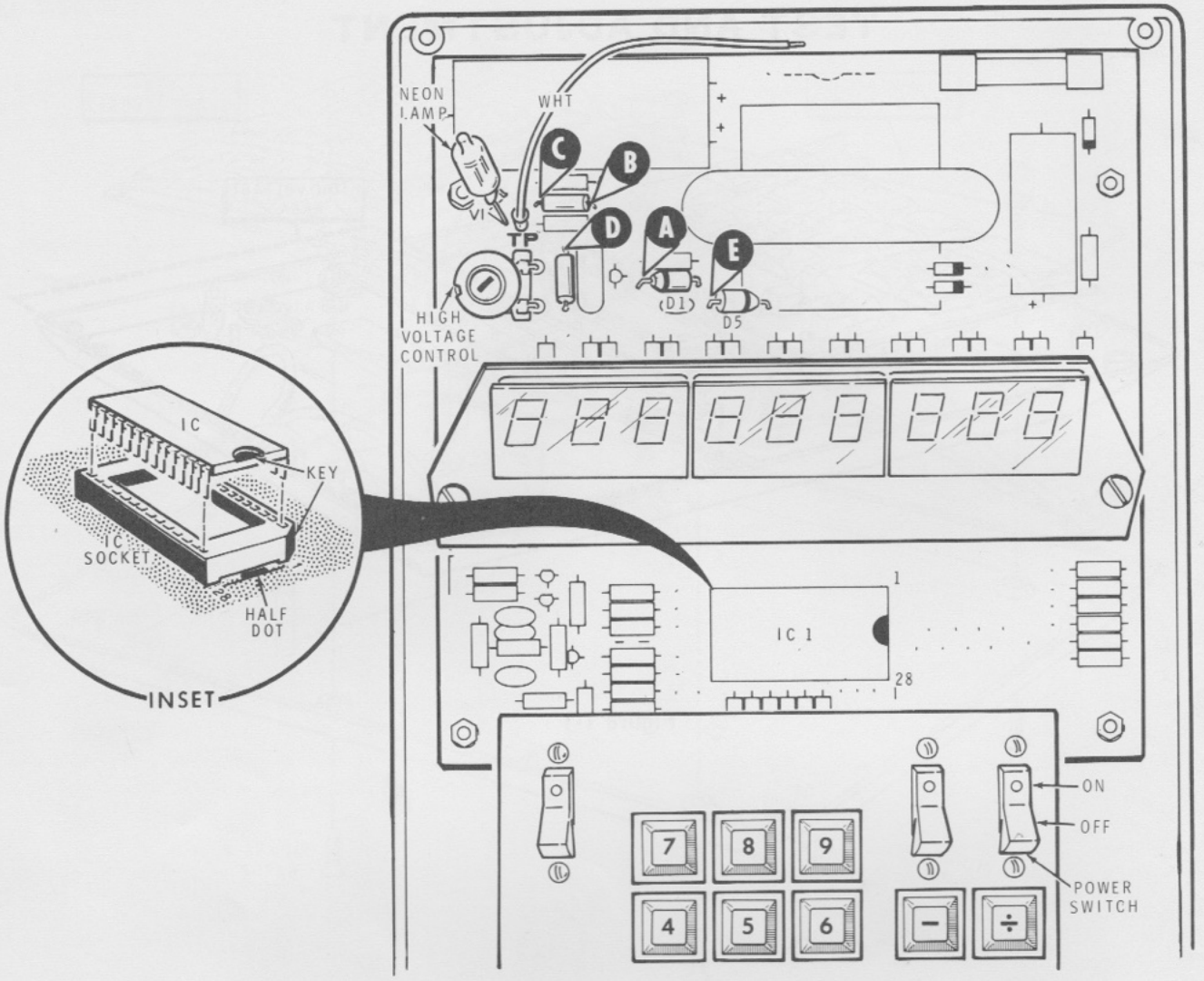


Figure 1-2

Refer to Figure 1-2 for the following steps.

( ) Prepare a 10" length of white wire.

( ) Insert one end of the white wire into the socket at TP. The other end of this wire will be used to touch various test points.

( ) Set the HIGH VOLTAGE control to its center of rotation.

( ) Press the POWER switch to the OFF position.

NOTE: If any trouble is encountered in the following steps, turn the power off and remove the line cord plug from the AC outlet. Then refer to the "In Case of Difficulty" section on Page 34.

( ) Connect the line cord plug to an AC outlet. One small dot at the bottom center of each tube should light.

( ) Press the POWER switch to the ON position.

NOTE: Hold only the insulation on the white wire in the following steps.

( ) Touch the end of the white wire to point A (lead on the banded end of diode D1) on the main circuit board. The neon lamp should glow.

( ) Touch the end of the white wire to point B (lead of the 10 kΩ brown-black-orange resistor) on the main circuit board. The neon lamp should glow.

( ) Touch the end of the white wire to point C (lead of the 10 kΩ brown-black-orange resistor) on the main circuit board. The neon lamp should glow.

( ) Touch the end of the white wire to point D (lead of the 68 kΩ blue-gray-orange resistor) on the main circuit board. The neon lamp should glow.

( ) Touch the end of the white wire to point E (lead of diode D5). The neon lamp should glow.

( ) Touch the end of the white wire to each connector at IC1. The neon lamp should not glow. If the neon lamp glows when the wire is touched to a connector, refer to the "In Case of Difficulty" section on Page 34.

( ) Press the POWER switch to the OFF position and remove the line cord plug from the AC socket.

( ) Remove the white wire from the socket at TP.

NOTE: The MOS integrated circuit that you will install in the next step is a rugged and reliable component. However normal static electricity discharged from your body through an integrated circuit pin to an object, such as the calculator, can damage the integrated circuit. Read the entire next step. Then carefully perform the step without interruption.

( ) Refer to Figure 1-2 and install a TMS0119 integrated circuit (#443-621) at IC1 as follows:

1. Remove the IC from its package, with both hands.
2. Hold the IC with one hand and straighten any bent pins with the other hand.
3. Contact the Transformer with your free hand before inserting the IC into its socket; keep one hand on either the IC or the transformer.
4. Position the keyed end of the IC over the keyed end of the socket (the half dot on the circuit board).
5. Be sure each IC pin is properly started into the socket; then push the IC down into the socket.

( ) Refer to Figure 1-3 and peel the backing paper from a 4-1/2" length of foam tape. Then press this foam tape onto the front of the readout tubes over the circle in each readout tube.

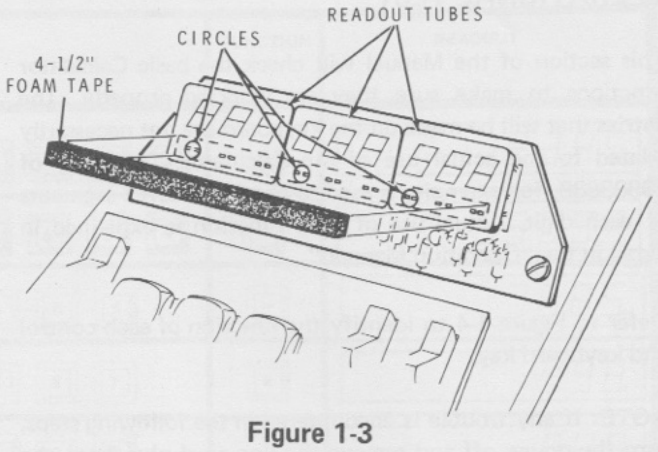


Figure 1-3

ADJUSTMENT

Make the following adjustment in a dimly lit area so that the readout numbers will appear brighter.

( ) Turn the HIGH VOLTAGE control full counterclockwise.

( ) Connect the line cord plug to an AC outlet.

( ) Press the POWER switch to the ON position. Allow about thirty seconds for warmup time.

( ) Press the C key to clear the Calculator. A zero should appear in the far right digit.

( ) Push the #8 key. You should have one digit, 8 brightly displayed on the readout. NOTE: Also, Some segments of digits to the left of the one brightly displayed digit "8" will be glowing.

( ) Now turn the HIGH VOLTAGE control slowly clockwise until the glowing just disappears from the unused segments.

( ) If, after a period of use, any segments that should not be lit tend to flicker or faintly glow, turn the HIGH VOLTAGE control slightly clockwise until the numbers become clear.

This completes the adjustment. Proceed with the "Operational Test."

OPERATIONAL TEST

This section of the Manual will check the basic Calculator functions to make sure they are working properly. The entries that will be made on the keyboard are not necessarily related to the actual use of the Calculator. The entry of 88888888, for example, is used to check the seven segments of each digit. Actual use of each function is explained in detail in the "Operation Manual."

Refer to Figure 1-4 to identify the function of each control and keyboard key.

NOTE: If any trouble is encountered in the following steps, turn the power off and remove the line cord plug from the AC outlet. Then refer to the "In Case of Difficulty" section on Page 34.

Each numbered step in the following charts shows which number and function keys to push, and what the readout will be. Always push the keys in the left-to-right sequence shown.

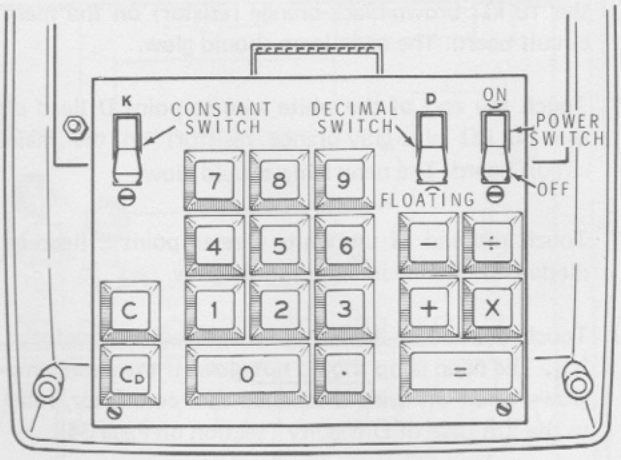


Figure 1-4

STEP	CONSTANT SWITCH	DECIMAL POINT SWITCH	INPUT	FUNCTION	READOUT
1	K ↓	D ↓	C		0.
2			8 8 8 8 8 8 8 8		88888888.
3			C		0.
4			1 · 2 3 4 5 6 7 8 9		1.23456789
5			CD		0.
6			− 2 3 4 5 6 7 8 9 0		E23456789.
7			C 3 4 5 6 7 8 9 · 0		3456789.0
8			C 9 9 9 9 9 9 9 9 9	X	999999999.
9			9	=	-8.999999999
10			C 9 9 9 9 9 9 9 9 9	X	999999999.
11			− 9	=	-8.999999999

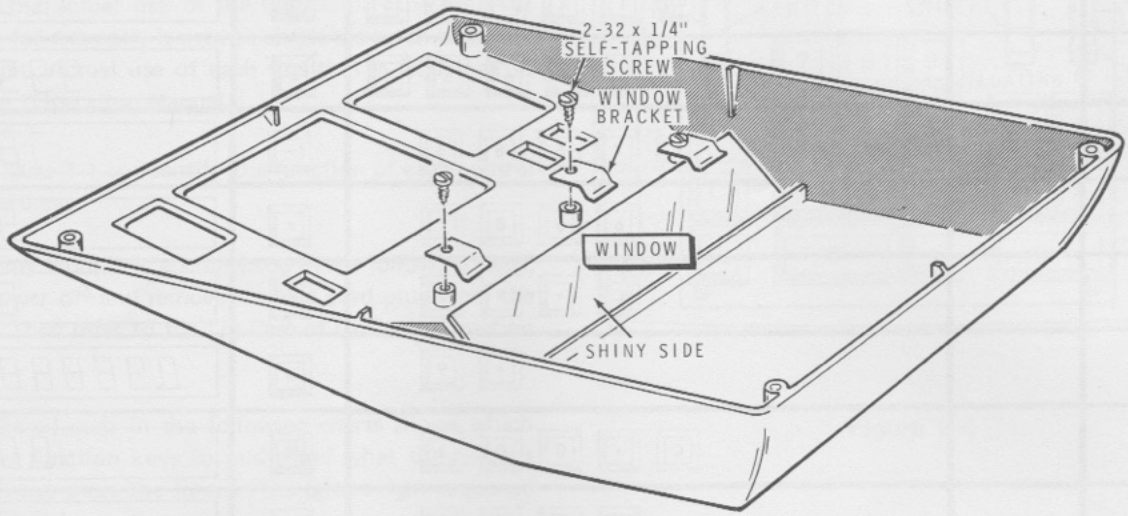
STEP	CONSTANT SWITCH	DECIMAL POINT SWITCH	INPUT	FUNCTION	READOUT
12			C 1 2 3 4 5	+	12345.
13			8 7 6 5 4	=	99999.
14			C 7 6 8 5	−	7685.
15			6 6 8 7	=	998.
16			C . 8 9	÷	0.89
17			. 9	=	0.9888888
18			C . 0 0 3	X	0.003
19			6 6 6 6	=	19.998
20			C 1	÷	1.
21	K ↑		1 6	=	0.0625
22			2	=	0.125
23			3	=	0.1875
24			4	=	0.25
25	K ↓		C		0.

( ) Press the POWER switch to the OFF position.

( ) Disconnect the line cord plug from the AC outlet.

This completes the "Operational Test." Proceed to "Final Assembly."

FINAL ASSEMBLY



PICTORIAL 5-1

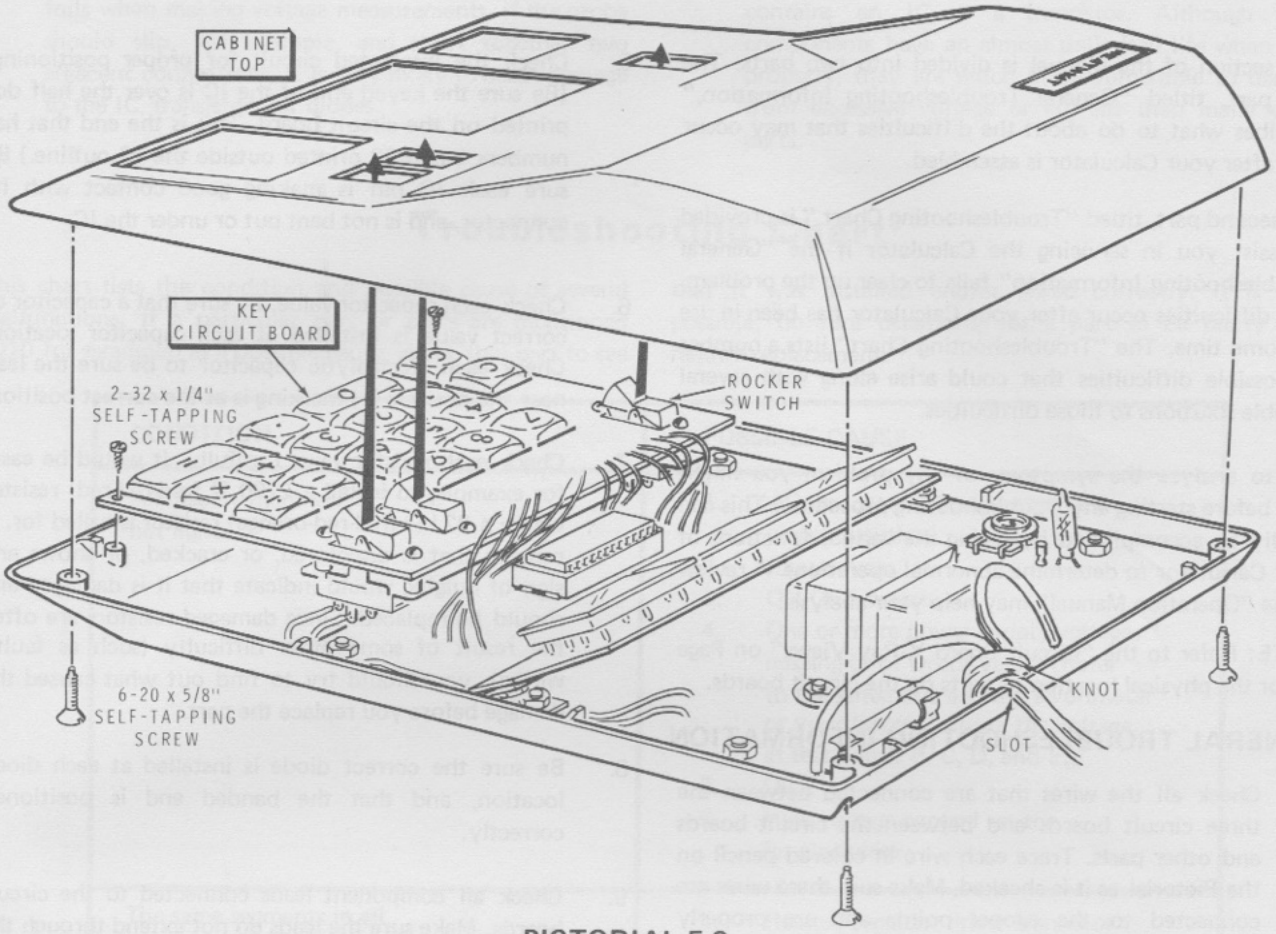
Refer to Pictorial 5-1 for the following steps.

NOTE: In the following steps, do not overtighten the self-tapping screws.

( ) Peel away the protective film from both sides of the window and wipe the window with a soft cloth.

NOTE: One side of the window is shiny and the other side is dull. Be sure to position the shiny side of the window toward the inside of the cabinet in the next step.

( ) Install the window in the cabinet top. Use three window brackets and three 2-32 x 1/4" self-tapping screws. Be sure the window is pressed fully into place.



PICTORIAL 5-2

Refer to Pictorial 5-2 for the following steps.

( ) Mount the key circuit board to the cabinet bottom with two 2-32 x 1/4" self-tapping screws. Do not tighten these screws. Push the wires that are connected to the top of the circuit board down against the board so they do not interfere with the mounting of the cabinet top.

Temporarily place the cabinet top on the Calculator. Make sure the line cord is in the slot with the knot inside the cabinet.

( ) Center the key circuit board so the keys are centered in the openings. Then carefully remove the cabinet top and tighten the two 2-32 screws without moving the board.

( ) Again place the cabinet top on the Calculator and center the three rocker switches in their openings. Remove the cabinet top and tighten the switch screws.

( ) Again place the cabinet top on the Calculator and look at the display tubes. They should be slightly above center and parallel to the window. If necessary, remove the cabinet and reposition the readout circuit board.

( ) Mount the cabinet top on the Calculator with four 6-20 x 5/8" self-tapping screws.

This completes the assembly of your Calculator. Refer to the "Operation Manual" for complete operating instructions.

IN CASE OF DIFFICULTY

This section of the Manual is divided into two parts. The first part, titled "General Troubleshooting Information," describes what to do about the difficulties that may occur right after your Calculator is assembled.

The second part, titled "Troubleshooting Chart," is provided to assist you in servicing the Calculator if the "General Troubleshooting Information" fails to clear up the problem, or if difficulties occur after your Calculator has been in use for some time. The "Troubleshooting Chart" lists a number of possible difficulties that could arise along with several possible solutions to those difficulties.

Try to analyze the symptoms of any problem you might have before starting any troubleshooting procedure. This can usually be accomplished by trying the various functions of your Calculator to determine abnormal operations. A review of the "Operation Manual" may help your analysis.

NOTE: Refer to the "Circuit Board X-Ray Views" on Page 41 for the physical location of parts on the circuit boards.

GENERAL TROUBLESHOOTING INFORMATION

1. Check all the wires that are connected between the three circuit boards and between the circuit boards and other parts. Trace each wire in colored pencil on the Pictorial as it is checked. Make sure these wires are connected to the proper points and are properly soldered. Someone who is not familiar with the unit may notice something you have consistently overlooked.

2. About 90% of the kits that are returned for repair do not function properly because of poor connections and soldering. Therefore, many troubles can be located by a careful inspection of connections to make sure they are soldered as described in the "Soldering" section of the "Kit Builders Guide." Reheat any doubtful connections.

3. Closely examine each circuit board foil in a good light to see that no solder bridges exist between adjacent connections. If available, a magnifying glass would be helpful for this purpose. Remove any solder bridges by holding a clean, hot soldering iron tip between the two points that are bridged until the excess solder flows down onto the tip. Compare your foil pattern against the "X-Ray Views" on Pages 42, 43, and 44.

4. Be sure each transistor is in its proper location (correct part number and/or type number). Be sure that each transistor lead is in the right hole and has a good solder connection to the foil. Recheck to see if you installed them as shown on Pages 6, 14, and 15.

5. Check the integrated circuit for proper positioning. (Be sure the keyed end of the IC is over the half dot printed on the circuit board. This is the end that has numbers 1 and 28 printed outside the IC outline.) Be sure each IC pin is making good contact with its connector, and is not bent out or under the IC.

6. Check each capacitor value. Be sure that a capacitor of correct value is installed at each capacitor location. Check each electrolytic capacitor to be sure the lead near the positive (+) marking is at the correct position.

7. Check each resistor value carefully. It would be easy, for example, to install a 2200 Ω (red-red-red) resistor where a 22 kΩ (red-red-orange) resistor is called for. A resistor that is discolored, or cracked, or shows any sign of bulging would indicate that it is damaged and should be replaced. Since damaged resistors are often the result of some other difficulty (such as faulty wiring), you should try to find out what caused the damage before you replace the part.

8. Be sure the correct diode is installed at each diode location, and that the banded end is positioned correctly.

9. Check all component leads connected to the circuit boards. Make sure the leads do not extend through the circuit board and come in contact with other connections or parts.

If you still cannot locate and correct the trouble after the above tests are completed, and if a voltmeter is available, check your Calculator's voltages against the voltages shown on the Schematic Diagram (fold-out from Page 47) and in the "Circuit Board Voltage Charts" (Page 45 and 46). If a voltmeter is not available, the tester that you assembled may be used to check for the presence of voltages of 59 volts or higher.

NOTE: In an extreme case where you are unable to resolve a difficulty, refer to the "Service" section of the "Kit Builders Guide" and to the "Factory Repair Service" information on Page 37 of this Manual. Your Warranty is located inside the front cover of the Manual.

Precautions For Troubleshooting

WARNING: Use extreme care when you measure voltages to prevent personal shock or instrument damage. Remember that hazardous voltages are exposed in the Calculator when the cabinet top is removed and the line cord is plugged into an AC outlet. See Figure 1-1 on Page 27.

1. Be sure you do not short any adjacent terminals or foils when making voltage measurements. If the probe should slip, for example, and short together two adjacent connections, it is very likely to cause damage to the IC, transistors, or diodes.

2. Be especially careful when testing any circuit that contains an IC or a transistor. Although these components have an almost unlimited life when used properly, they are much more vulnerable to damage from excessive voltage or current than many other parts.

Troubleshooting Chart

This chart lists the condition and possible cause of several malfunctions. If a particular part or parts are mentioned (Q10 for example) as a possible cause, check that part to see that it was installed and/or wired correctly. It is also possible, on rare occasions, for a part to be faulty and require replacement.

CONDITION	POSSIBLE CAUSE
All display digits will not light.	1. AC line cord not connected to a working outlet. 2. Blown fuse. 3. ON-OFF switch. 4. One or more power supply voltages missing or of wrong value. (Refer to the schematic and use a voltmeter or your tester to check the voltage at test points B, C, D, and E.) 5. Q22. 6. High voltage control set too far clockwise.
The same segments in all display digits will not light.	1. Related segment driver transistor (Q23 thru Q30). See Pages 6, 14, and 15. 2. Wiring between main and readout circuit boards.
One or more different segments in one or more display digits will not light.	1. One or more bent pins on V101-V103. 2. Short between one or more readout circuit board foils.
Blue glow exists between adjacent display digits. One digit dimly displays the same lighted segments as an adjacent digit. All digits glow dimly when lighted.	1. High Voltage control not properly adjusted. 2. Q22.
Number or function entered does not appear on readout.	1. Broken wires between keyboard and main board. 2. One or more shorted key switches.

CONDITION	POSSIBLE CAUSE
The same segment in all tubes light consistantly.	1. The cathode driver transistor for that segment shorted or incorrectly installed. See Page 6. 2. Solder bridge between foils on the readout circuit board. 3. Foil on readout board shorted to mounting bracket.
Ones (far right) digit will not light.	1. Pin 9 bent on associated readout tube. 2. Transistor Q18 or Q9 incorrectly installed or defective. See Pages 14 and 15.
Tens (second from right) digit will not light.	1. Pin 9 bent on associated readout tube. 2. Transistor Q17 or Q8 incorrectly installed or defective.
Hundreds (third from right) digit will not light.	1. Pin 9 bent on associated readout tube. 2. Transistor Q16 or Q7 incorrectly installed or defective.
Thousands (fourth from right) digit will not light.	1. Pin 9 bent on associated readout tube. 2. Transistor Q15 or Q6 incorrectly installed or defective.
Ten thousands (fifth from right) digit will not light.	1. Pin 9 bent on associated readout tube. 2. Transistor Q14 or Q5 incorrectly installed or defective.
Hundred thousands (sixth from right) digit will not light.	1. Pin 9 bent on associated readout tube. 2. Transistor Q13 or Q4 incorrectly installed or defective.
Millions (seventh from right) digit will not light.	1. Pin 9 bent on associated readout tube. 2. Transistor Q12 or Q3 incorrectly installed or defective.
Ten millions (eight from right) digit will not light.	1. Pin 9 bent on associated readout tube. 2. Transistor Q11 or Q2 incorrectly installed or defective.
Overrange (far left) digit will not light.	1. Pin 9 bent on associated readout tube. 2. Transistor Q10 or Q1 incorrectly installed or defective.

FACTORY REPAIR SERVICE

You can return your completed kit to the Heath Company Service Department to have it repaired for a minimum service fee. (Kits that have been modified will not be accepted for repair.) Or, if you wish, you can deliver your kit to a nearby Heathkit Electronic Center. These centers are listed in your Heathkit catalog.

To be eligible for replacement parts under the terms of the warranty, equipment returned for factory repair service, or delivered to a Heathkit Electronic Center, must be accompanied by the invoice or the sales slip, or a copy of either. If you send the original invoice or sales slip, it will be returned to you.

If it is not convenient to deliver your kit to a Heathkit Electronic Center, please ship it to the factory at Benton Harbor, Michigan and observe the following shipping instructions:

Prepare a letter in duplicate, containing the following information:

- Your name and return address.
- Date of purchase.
- A brief description of the difficulty.
- The invoice or sales slip, or a copy of either.
- Your authorization to ship the repaired unit back to you C.O.D. for the service and shipping charges, plus the cost of parts not covered by the warranty.

Attach the envelope containing one copy of this letter directly to the unit before packaging, so that we do not overlook this important information. Send the second copy of the letter by separate mail to Heath Company, Attention: Service Department, Benton Harbor, Michigan 49022.

Check the equipment to see that all parts and screws are in place. Then, wrap the equipment in heavy paper. Place the equipment in a strong carton, and put at least THREE INCHES of resilient packing material (shredded paper, excelsior, etc.) on all sides, between the equipment and the carton. Seal the carton with gummed paper tape, and tie it with a strong cord. Ship it by prepaid express, United Parcel Service, or insured parcel post to:

Heath Company
Service Department
Benton Harbor, Michigan 49022

SPECIFICATIONS

DISPLAY

Readout	8-digit; 7-segment; single-plane.
Input Overrange	Indicated when input exceeds 8-digit capacity.
Resultant Overrange	Indicated when result exceeds 8-digit capacity.
Sign	Negative (—) used for negative numbers.

KEYBOARD

Eighteen Keys	10 number keys (0-9). 1 decimal point key (.). 4 function keys (+, —, X, ÷). 1 equals key (=). 1 clear key (C). 1 clear display key (C_D).
Switches	On-Off; Constant factor (K); Decimal point, fixed or floating.

CAPABILITIES

Functions	Addition. Subtraction. Multiplication. Division.
Computation Modes	Chain or constant.
Range	10^{-7} to 10^{8} (0.0000001 to 99999999).
Decimal Point Positions	1 fixed (one of eight optional positions.) 1 floating.

GENERAL

Operating Temperature	10 to 40 degrees C. 50 to 104 degrees F.
Line Voltage	120/240 volts AC, 50/60 Hz.
Power	5 watts.
Protection	1/8-ampere slow-blow fuse (120 VAC operation). 1/16-ampere slow-blow fuse (240 VAC operation).
Dimensions	9-5/8" long x 7" wide x 2-1/4" high.
Weight	2.5 lbs.

The Heath Company reserves the right to discontinue instruments and to change specifications at any time without incurring any obligation to incorporate new features in instruments previously sold.

CIRCUIT FUNDAMENTALS

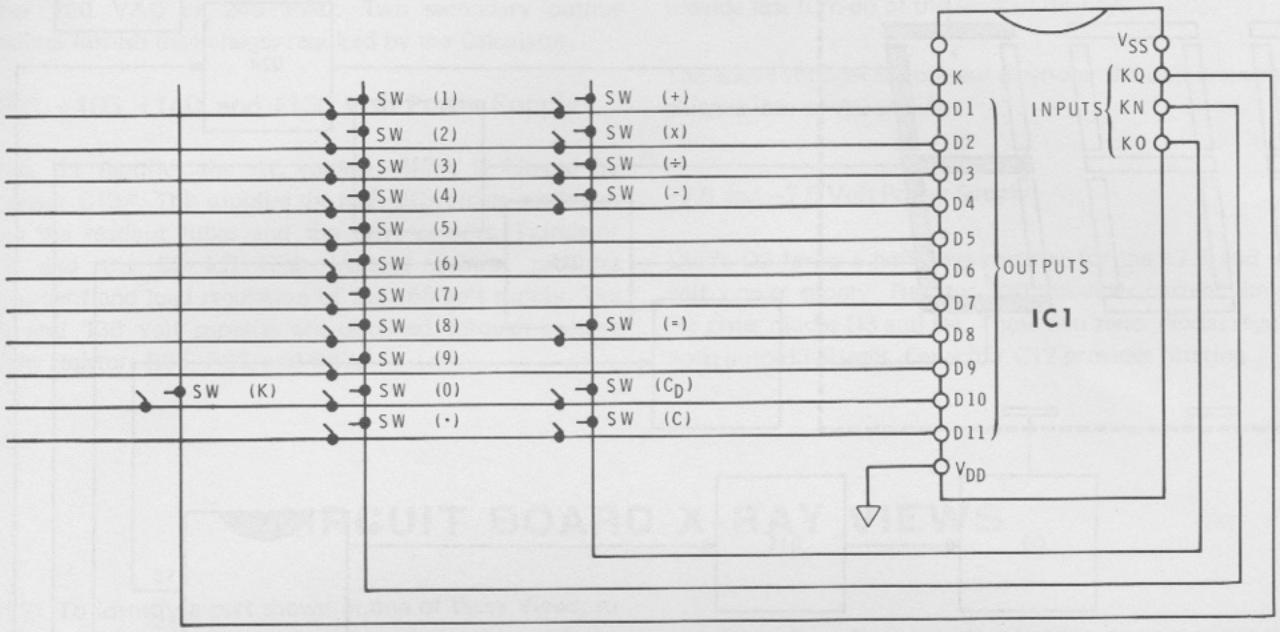


Figure 2-1

Mathematical calculations are made possible in the Calculator through the use of many interrelated circuits that are programmed to act in a timed sequence. These "Circuit Fundamentals" will give you a better understanding of the circuit relationships within your Calculator and describe how they work together. Refer to the individual Figures as they are called for, and to the Schematic Diagram (fold-out from Page 47), while you read this information.

IC1

IC1 (Integrated Circuit 1) is the heart of your Calculator. This single "package" contains all the circuits that perform addition, subtraction, multiplication, and division. IC1 can perform these functions either individually or in continuous series.

Transistors Q19, Q20, Q21 form an oscillator circuit that provides a signal of approximately 200 kHz to the Φ input of IC1. This signal causes the internal circuits of IC1 to repeatedly scan the inputs and to pulse the outputs in rapid sequence; this sequence is repeated over and over. This scanning principle, known as multiplexing, is a form of "time sharing" that allows some of the outputs of IC1 to be used for both Keyboard inputs and Readout display outputs and reduces the number of pins that would otherwise be required on the IC.

IC1 is also internally programmed to provide protection against key double-entry and transient noise signals. Each time a key is pressed, the IC samples the key switch entry. The same entry is sampled again 2.5 milliseconds later to determine its validity. If the entry is proven valid, the IC memorizes and transfers that particular entry to the driving circuits that light the Readout.

Automatic locking circuits, within IC1, prevent the entry of more than eight digits into the Calculator.

KEYBOARD

Mathematical commands and numbers are entered into the Calculator through the individual keys of the Keyboard. Each Keyboard switch is connected between an input and output line of IC1 (Figure 2-1). Pressing the keys provides IC1 with the necessary information to perform the mathematics of the particular problem entered.

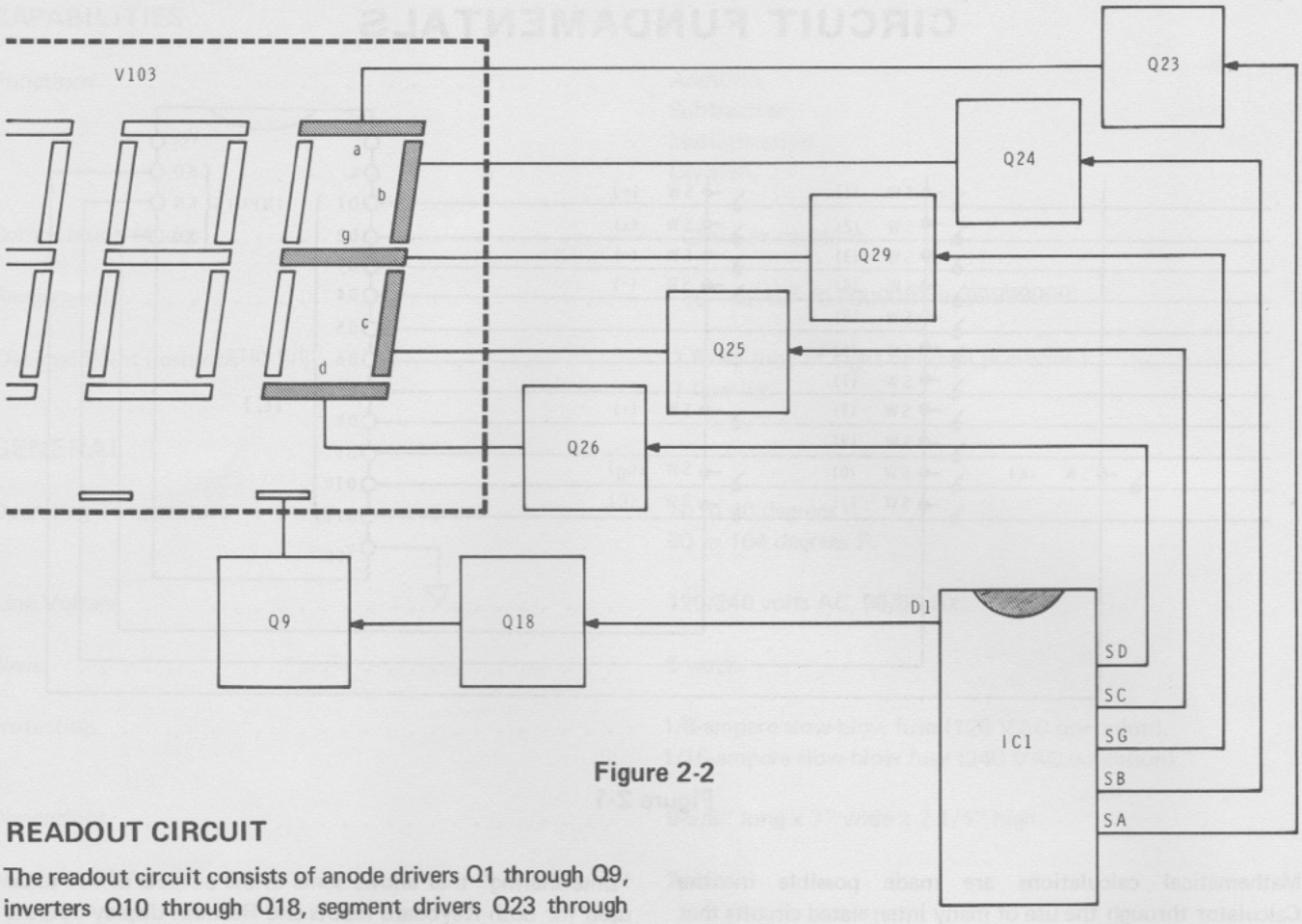


Figure 2-2

READOUT CIRCUIT

The readout circuit consists of anode drivers Q1 through Q9, inverters Q10 through Q18, segment drivers Q23 through Q30, and readout tubes V101 through V103. Inverters Q10 through Q18, controlled by the multiplexing (scanning action) of IC1, turn the anode drivers on and off. The anode drivers, in turn, act as electronic switches that turn on and off each digit section of the readout tubes. This results in a continuous switching on and off of each digit at a rate and sequence determined by the multiplexing action of IC1. The multiplexing of IC1 is at a rate fast enough to cause each digit to appear as a steady indication to the eye.

Segment drivers Q23 through Q30 are controlled by the internal circuits of IC1. These drivers apply voltage to the appropriate segments of the readout tubes to form numerical displays. To light a segment, a particular anode driver and a particular cathode driver must both be on at the same time.

DECIMAL POINT SWITCH

The 2-position Decimal Point switch provides IC1 with the necessary information for either floating or fixed decimal point operation. The F (floating) position remains unconnected to allow the decimal point to be automatically placed in the correct location. In the fixed decimal position, the KP input of IC1 is connected to one of the eight D outputs of IC1. For example, if the connection was made to D10, the fixed decimal would be in the 0 position.

TYPICAL READOUT LIGHTING

Figure 2-2 shows the driving circuits required to light the numeral 3 in the ones digit section (extreme right-hand position) of V103.

To form the numeral "3," IC1 supplies a turn-on signal through its SA, SB, SC, SD, and SG outputs. (Notice that these outputs stand for Segment A, Segment B, etc.) These signals cause transistors Q23, Q24, Q25, Q26, and Q29 to ground their respective segments. Since all respective segments of the readout tubes are in parallel, any time that anode voltage is applied to a digit, that digit will display a "3".

The internal timing circuit in IC1 determines which digit will have the anode voltage applied to it. In order for the right hand (ones) digit to light, the D1 output of IC1 supplies a turn-on signal to transistor Q18. This in turn conducts to allow Q9 to apply a high voltage through pin 9 to light the "ones" digit. This lights the segments to display a number 3.

POWER SUPPLY

Dual-primary transformer T1 can be wired to operate from either 120 VAC or 240 VAC. Two secondary output windings furnish the voltages required by the Calculator.

−180, +165, +140, and +130 Volt Power Supply

Diode D1 rectifies the AC voltage, which is filtered by capacitor C13A. This supplies the high DC voltage needed to drive the readout tubes and the drive circuits. Transistor Q22 and the 50 kΩ High Voltage control provides adjustment and load regulation of the 165 volt supply. The 140 and 130 volt supplies are obtained through voltage divider resistors R85, R86, and R87.

The −180 volt supply is established by diode D5 and filter capacitor C11. This voltage is applied to each readout tube through current limiting resistors R78, R79, and R80, to provide fast turn-on of the readout displays.

The above voltages are present whenever the unit line cord is plugged into an AC socket.

+7.5 and −7.5 Volt Power Supply

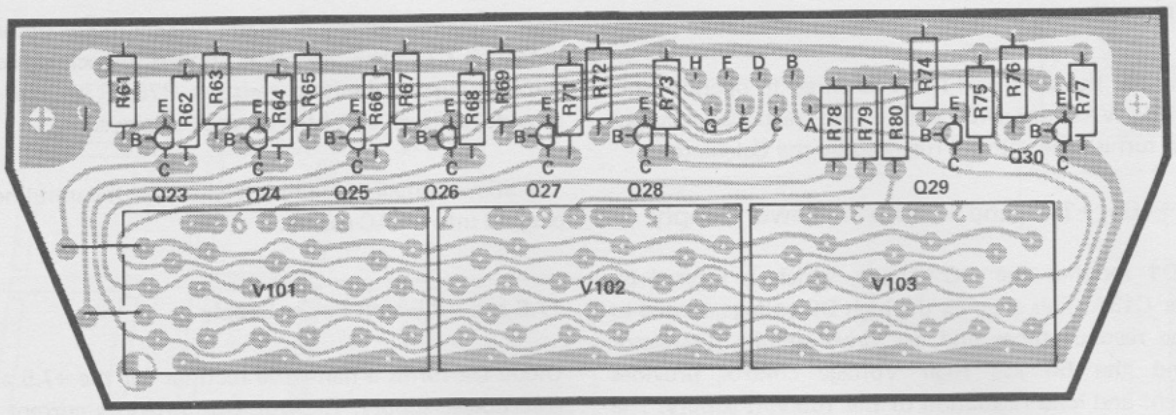
Diode D2 forms a half-wave rectifier for the +7.5 and −7.5 volt power supply. Resistor R81 provides current limiting for zener diodes D3 and D4. These two zener diodes regulate both output voltages. Capacitor C12 provides filtering.

CIRCUIT BOARD X-RAY VIEWS

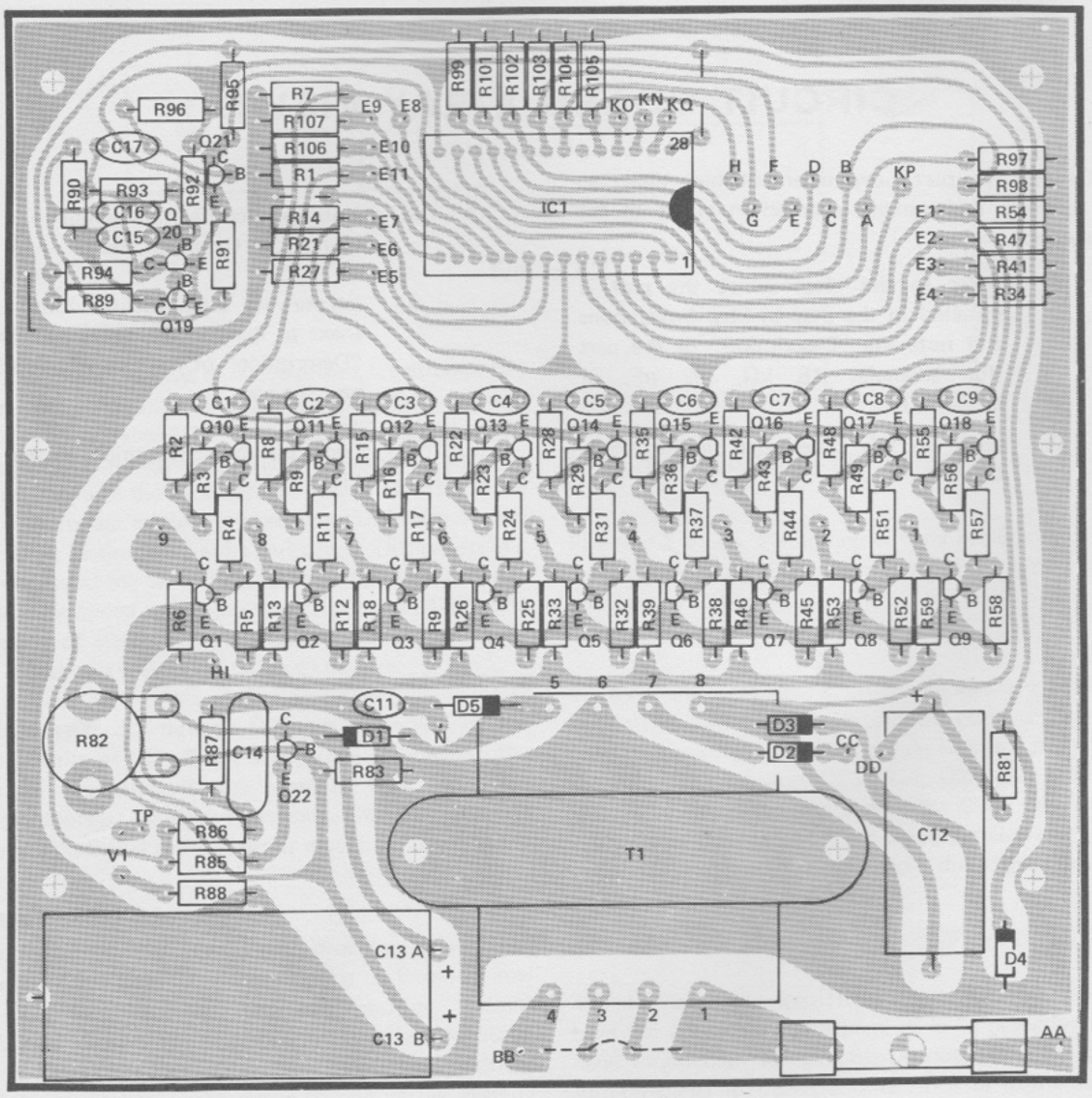
NOTE: To identify a part shown in one of these Views, so you can order a replacement, proceed in either of the following ways:

1. A. Refer to the place where the part is installed in the Step-by-Step instructions and note the "Description" of the part (for example: 18 kΩ, .02 μF, or MPS-A42).
   B. Look up this Description in the "Parts List."

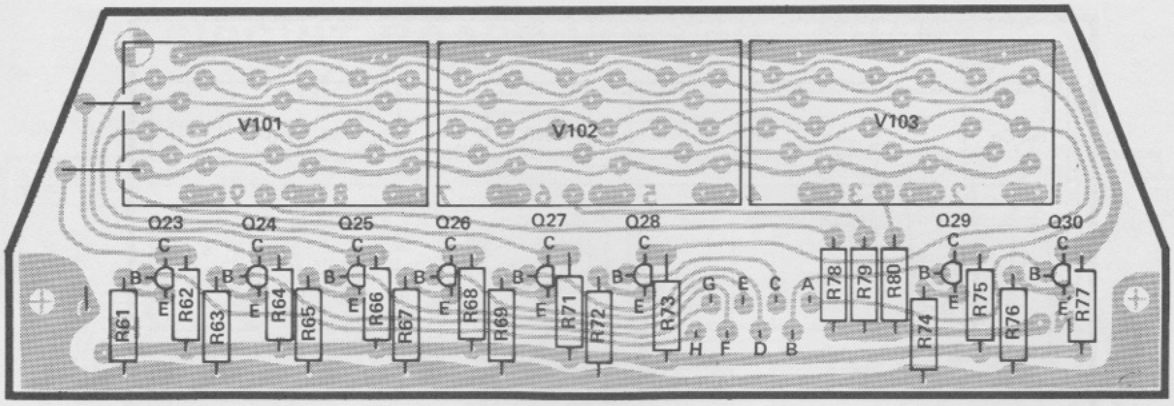
2. A. Note the identification number of the part (R-number, C-number, etc.).
   B. Locate the same identification number (next to the part) on the Schematic. The "Description" of the part will also appear near the part.
   C. Look up this Description in the "Parts List."



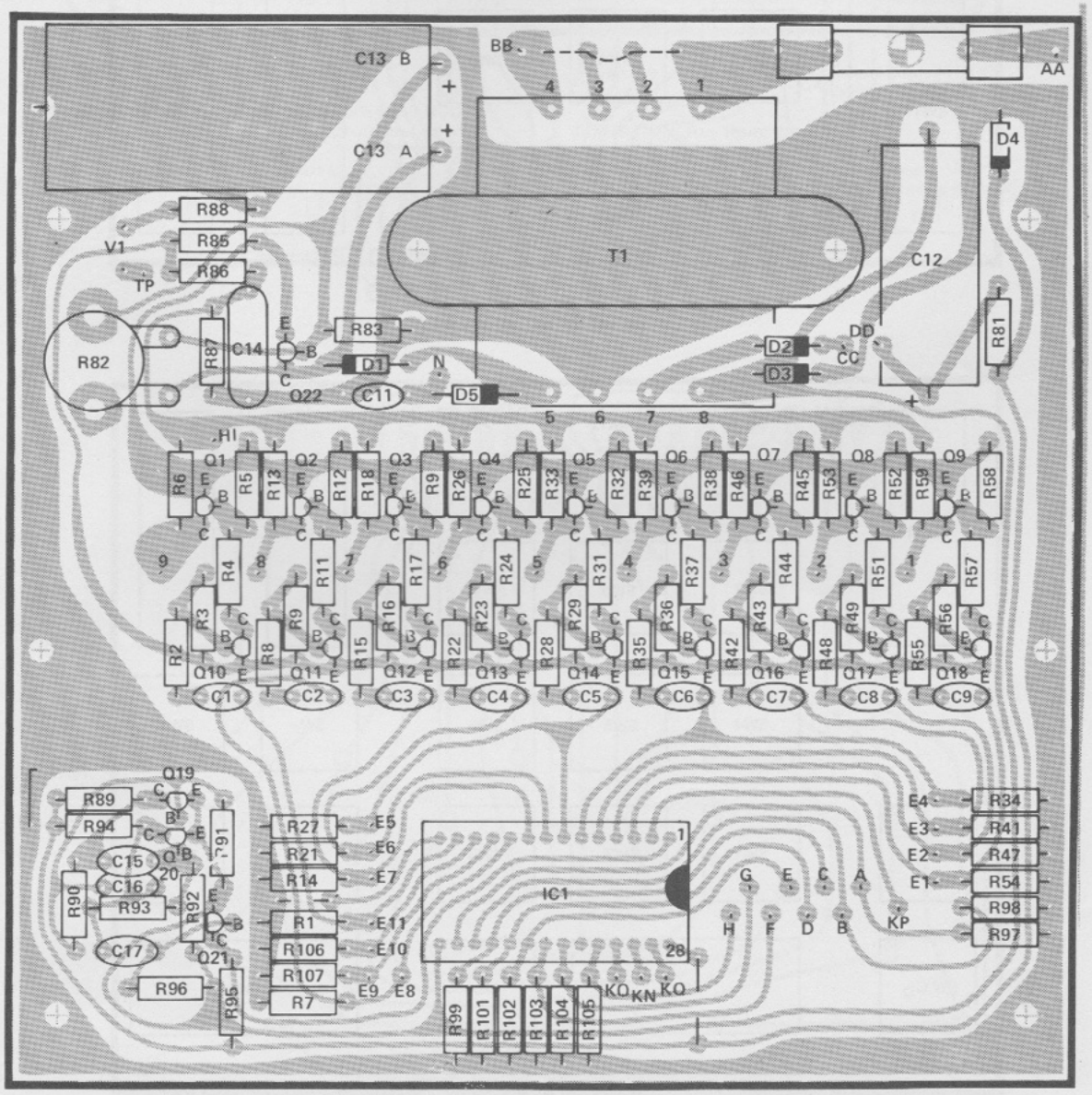
READOUT CIRCUIT BOARD
(Viewed from foil side)



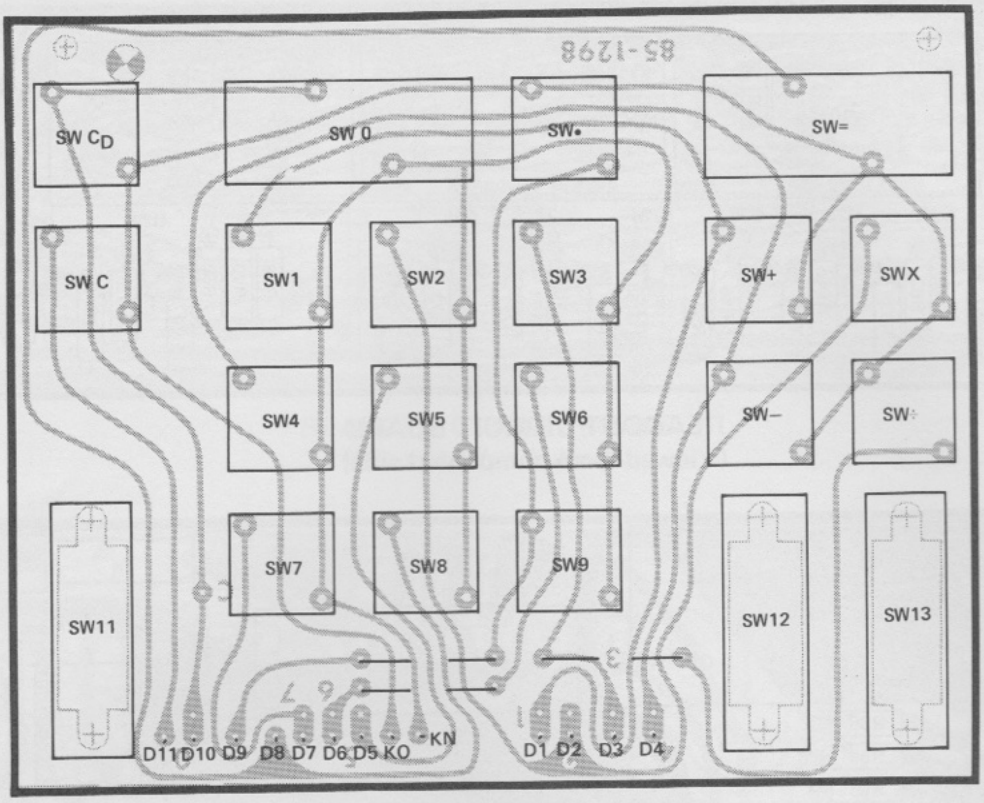
MAIN CIRCUIT BOARD
(Viewed from foil side)



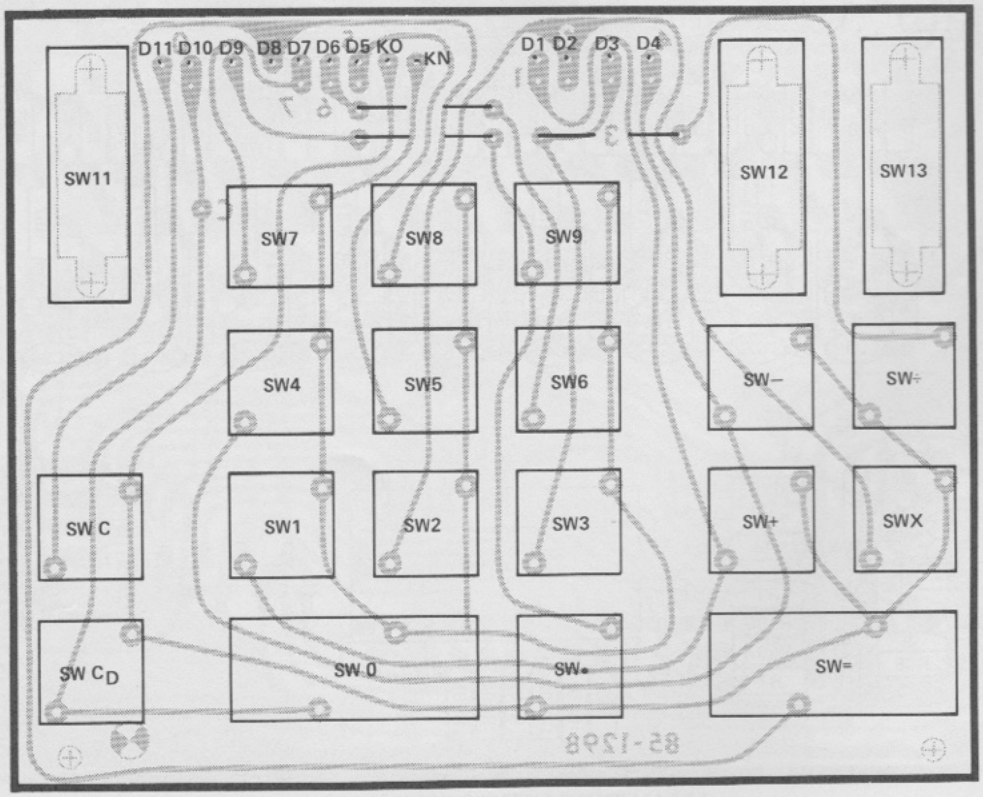
READOUT CIRCUIT BOARD
(Viewed from component side)



MAIN CIRCUIT BOARD
(Viewed from component side)



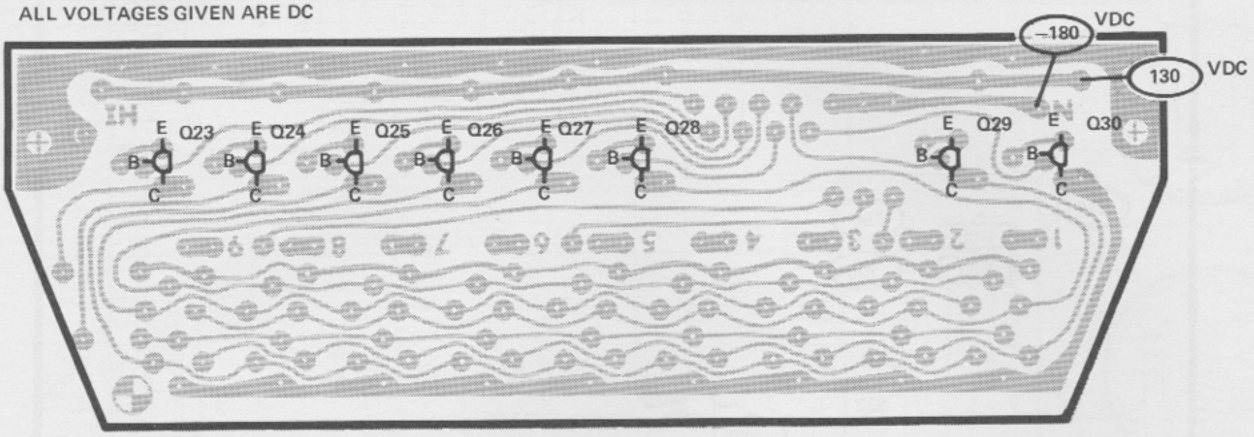
KEYBOARD CIRCUIT BOARD
(Viewed from foil side)



KEYBOARD CIRCUIT BOARD
(Viewed from component sie)

CIRCUIT BOARD VOLTAGE CHART

ALL VOLTAGES GIVEN ARE DC



CONDITION: All 8's displayed on readout.

Transistors Q24 through Q30 — Base voltage 5.3 VDC
Emitter voltage 4.9 VDC

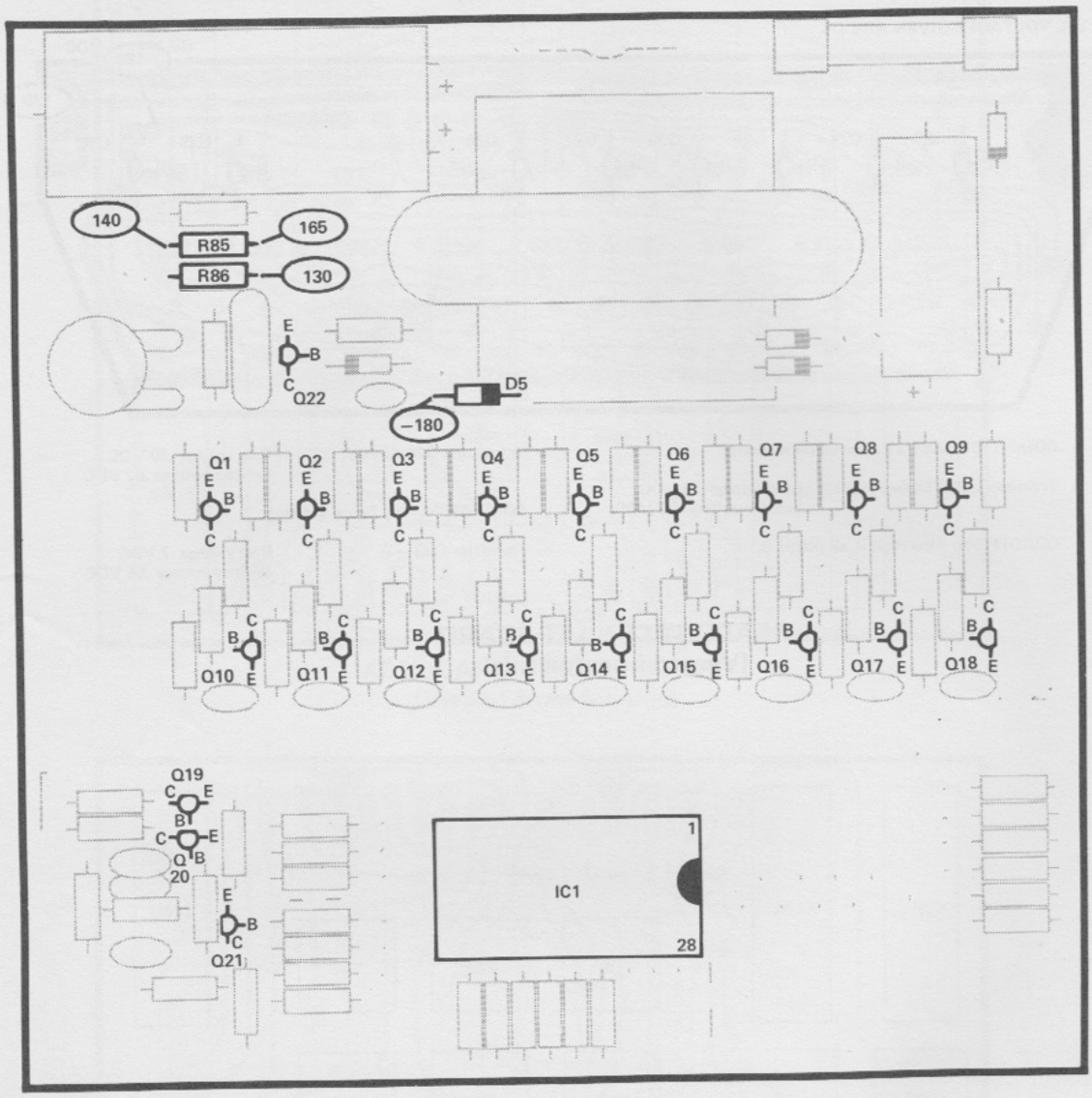
CONDITION: First digit 8, all others 0.

Transistors Q24 thorugh Q30 — Base voltage .70 VDC
Emitter voltage .62 VDC

CONDITION: Any figure showing.

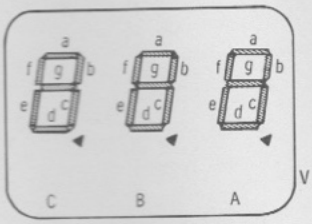
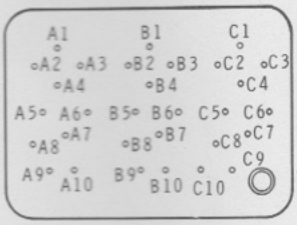
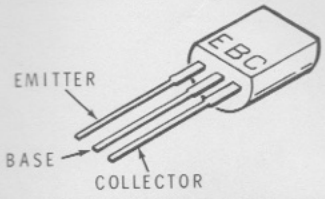
Transistor Q23 — Base voltage .7 VDC
Emitter voltage .65 VDC

READOUT CIRCUIT BOARD
(Viewed from foil side)

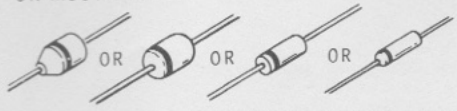
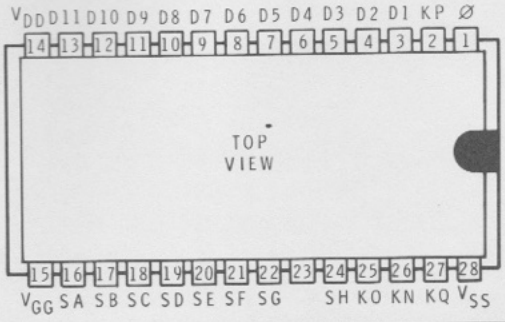


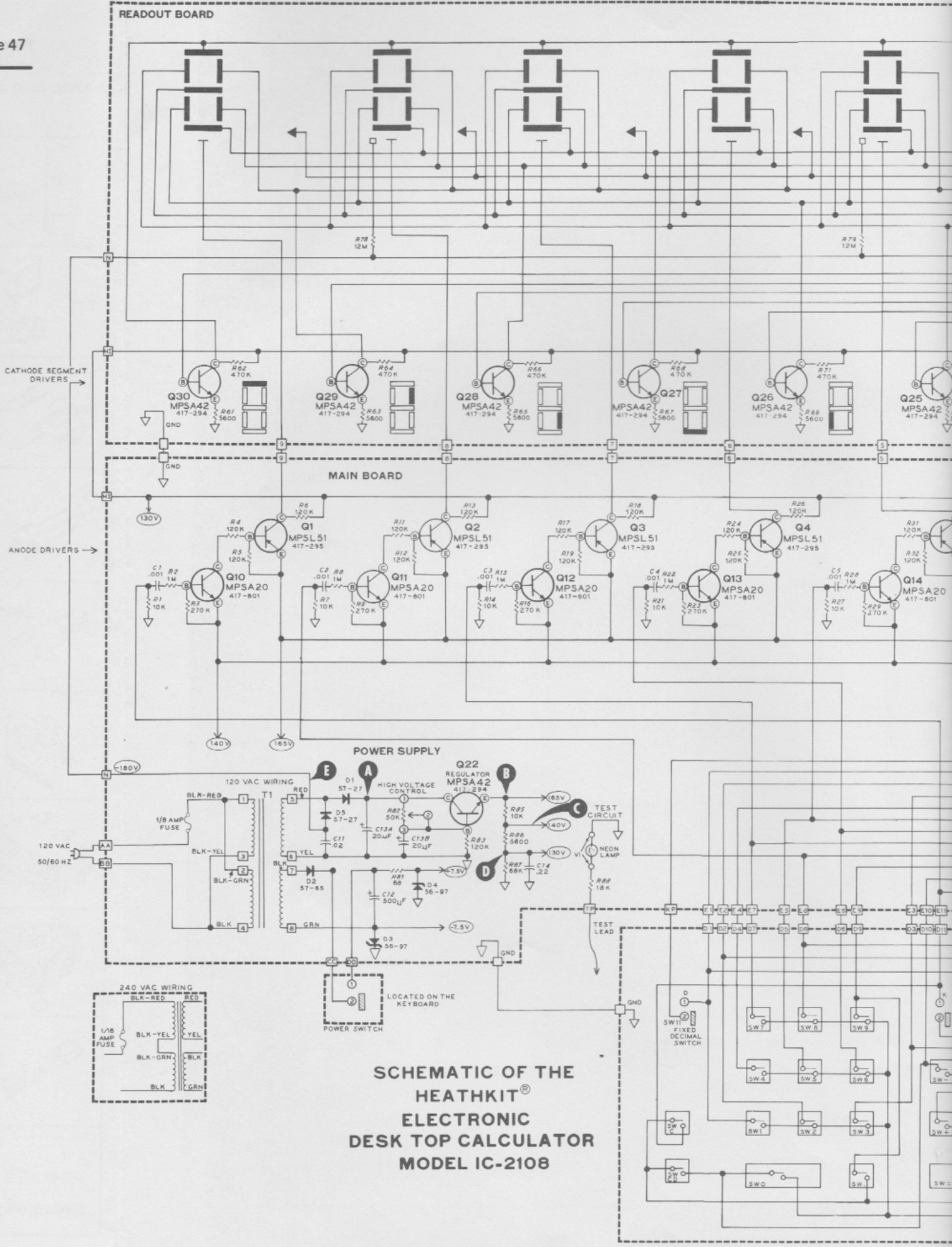
MAIN CIRCUIT BOARD
(Viewed from component side)

Semiconductor Identification Chart

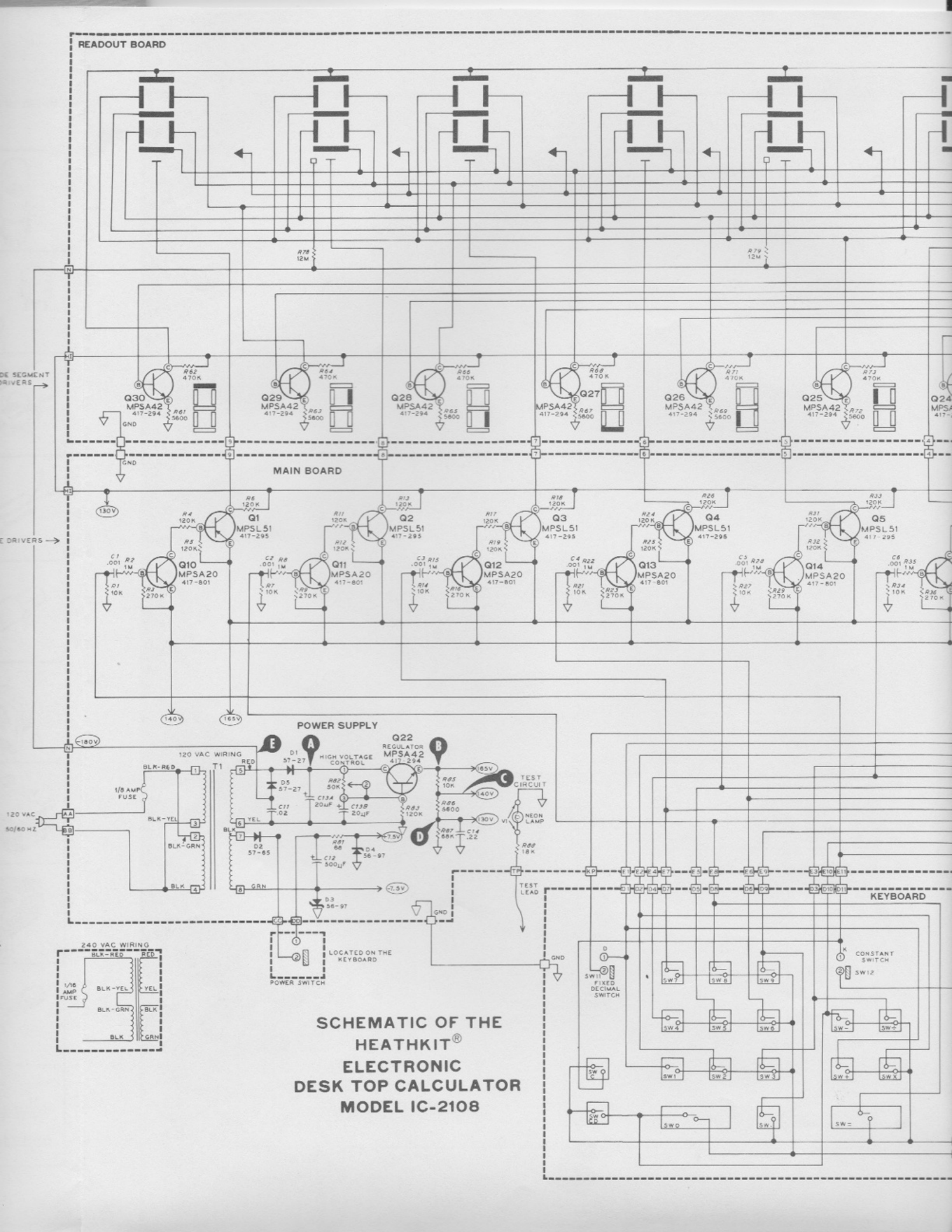
COMPONENT	HEATH PART NUMBER	MAY BE REPLACED WITH	IDENTIFICATION
V1, V2, V3	411-290	SPERRY RAND SP-353	 SEGMENTS VIEWED FROM FRONT  PINS VIEWED FROM BACK NOTE: A10 AND C10 NOT USED.
Q22-Q30	417-294	MPS-A42	
Q1-Q9	417-295	MPS-L51	
Q10-Q21	417-801	MPS-A20	

SEGMENT	PIN NUMBER
a	1
b	2
c	3
d	4
e	5
f	6
g	7
DECIMAL	8
ANODE	9
"KEEP ALIVE"	10

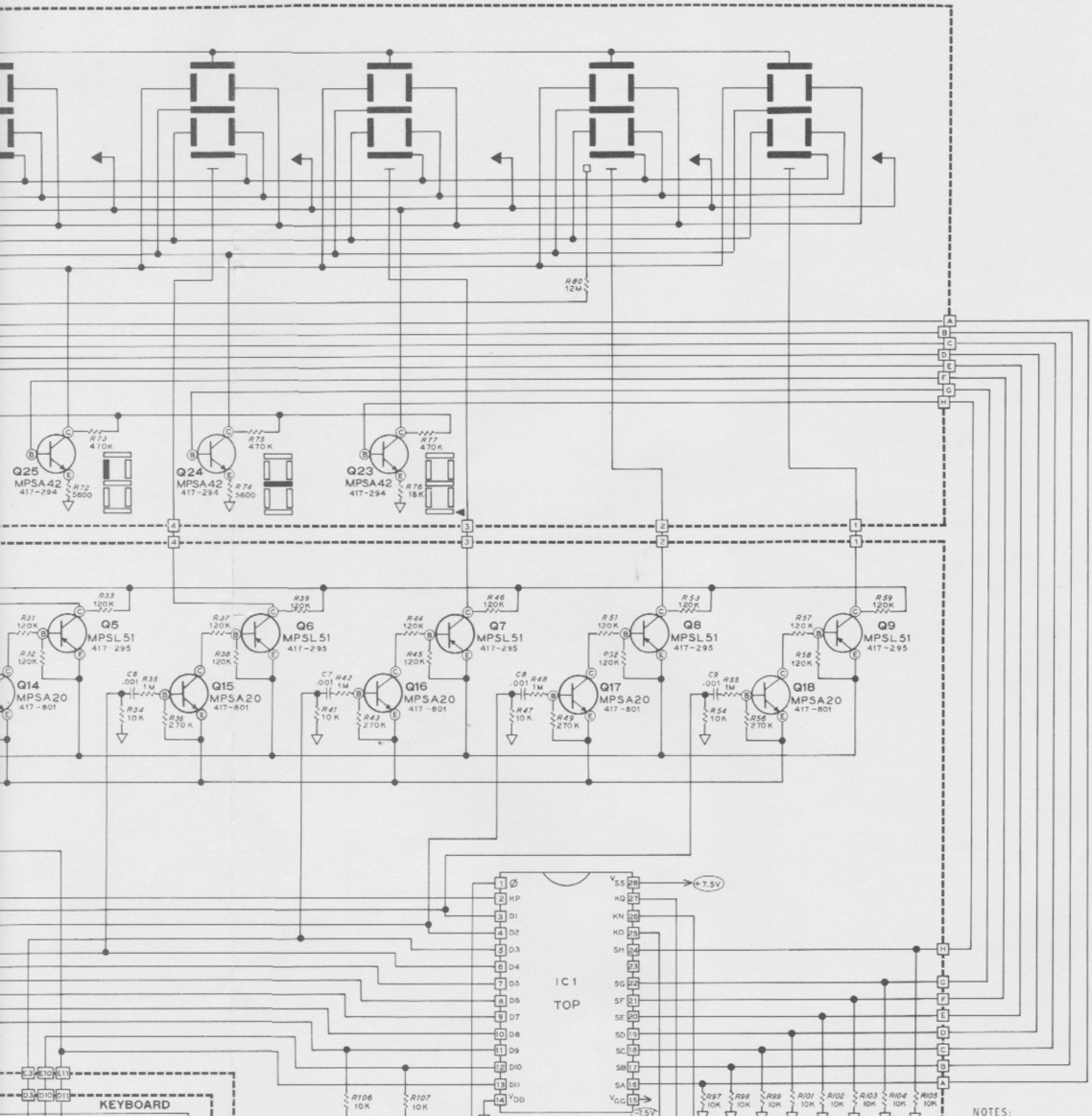
COMPONENT	HEATH PART NUMBER	MAY BE REPLACED WITH	IDENTIFICATION
D2	57-65	1N4002 SILICON DIODE, 1A, 100V.	NOTE: HEATH PART NUMBERS ARE STAMPED ON MOST DIODES. 
D3, D4	56-97	1N3017 ZENER DIODE, 7.5V, 34mA.	
D1, D5	57-27	1N2071 SILICON DIODE, 1A, 600V.	
IC1	443-623	TMS0119	



SCHEMATIC OF THE HEATHKIT® ELECTRONIC DESK TOP CALCULATOR MODEL IC-2108

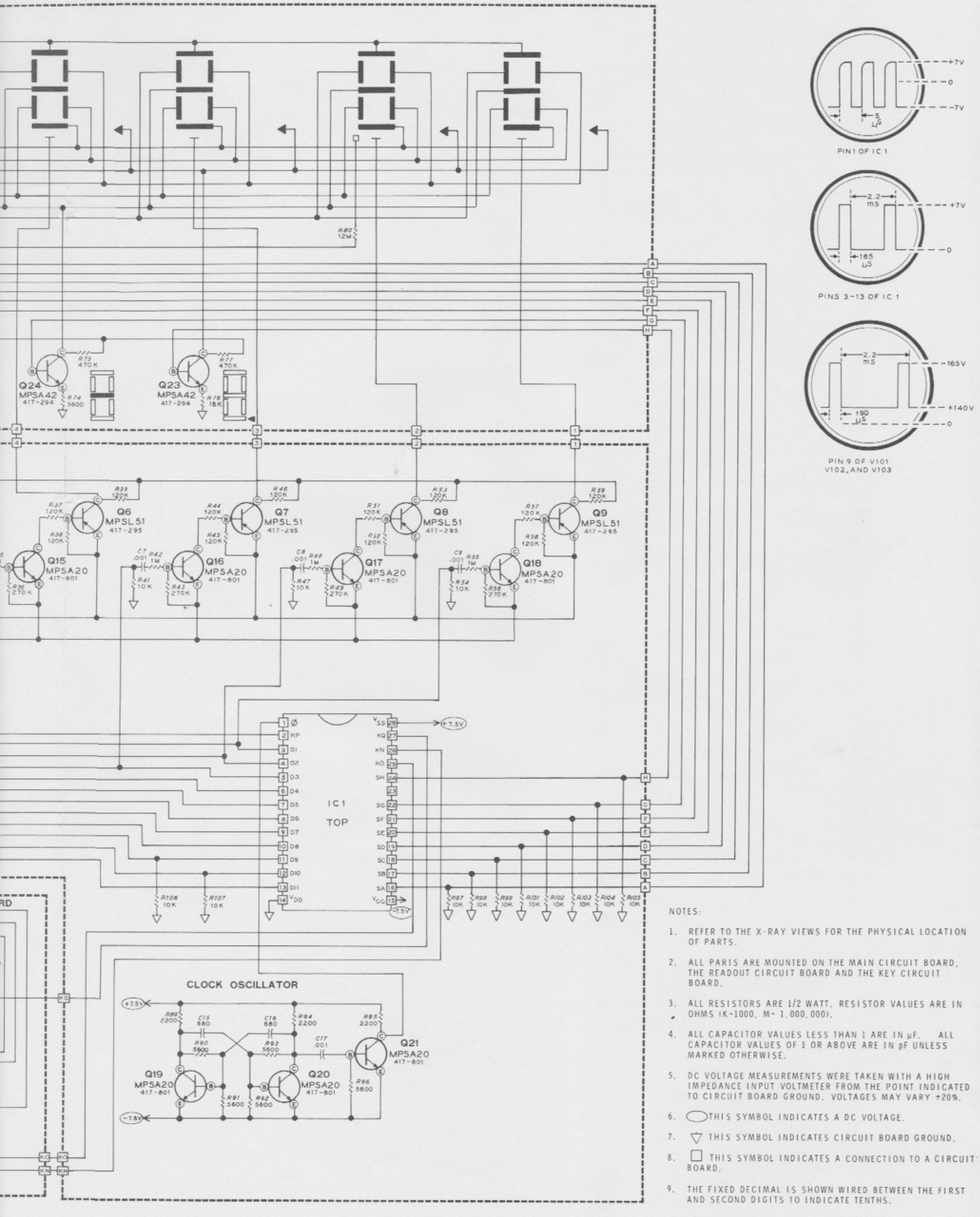


SCHEMATIC OF THE HEATHKIT® ELECTRONIC DESK TOP CALCULATOR MODEL IC-2108



NOTES:

1. REFER TO THE X-RAY VIEWS FOR THE OF PARTS.
2. ALL PARTS ARE MOUNTED ON THE MA THE READOUT CIRCUIT BOARD AND T BOARD.
3. ALL RESISTORS ARE 1/2 WATT. RESI OHMS (K=1000, M= 1,000,000).
4. ALL CAPACITOR VALUES LESS THAN CAPACITOR VALUES OF 1 OR ABOVE MARKED OTHERWISE.
5. DC VOLTAGE MEASUREMENTS WERE TA IMPEDANCE INPUT VOLTMETER FROM TO CIRCUIT BOARD GROUND. VOLTA
6. ⬭ THIS SYMBOL INDICATES A DC
7. ▽ THIS SYMBOL INDICATES CIRCU
8. □ THIS SYMBOL INDICATES A CON BOARD.
9. THE FIXED DECIMAL IS SHOWN WIRE AND SECOND DIGITS TO INDICATE TE
10. ◯ THIS SYMBOL INDICATES POWER



PIN 1 OF IC 1

PINS 3-13 OF IC 1

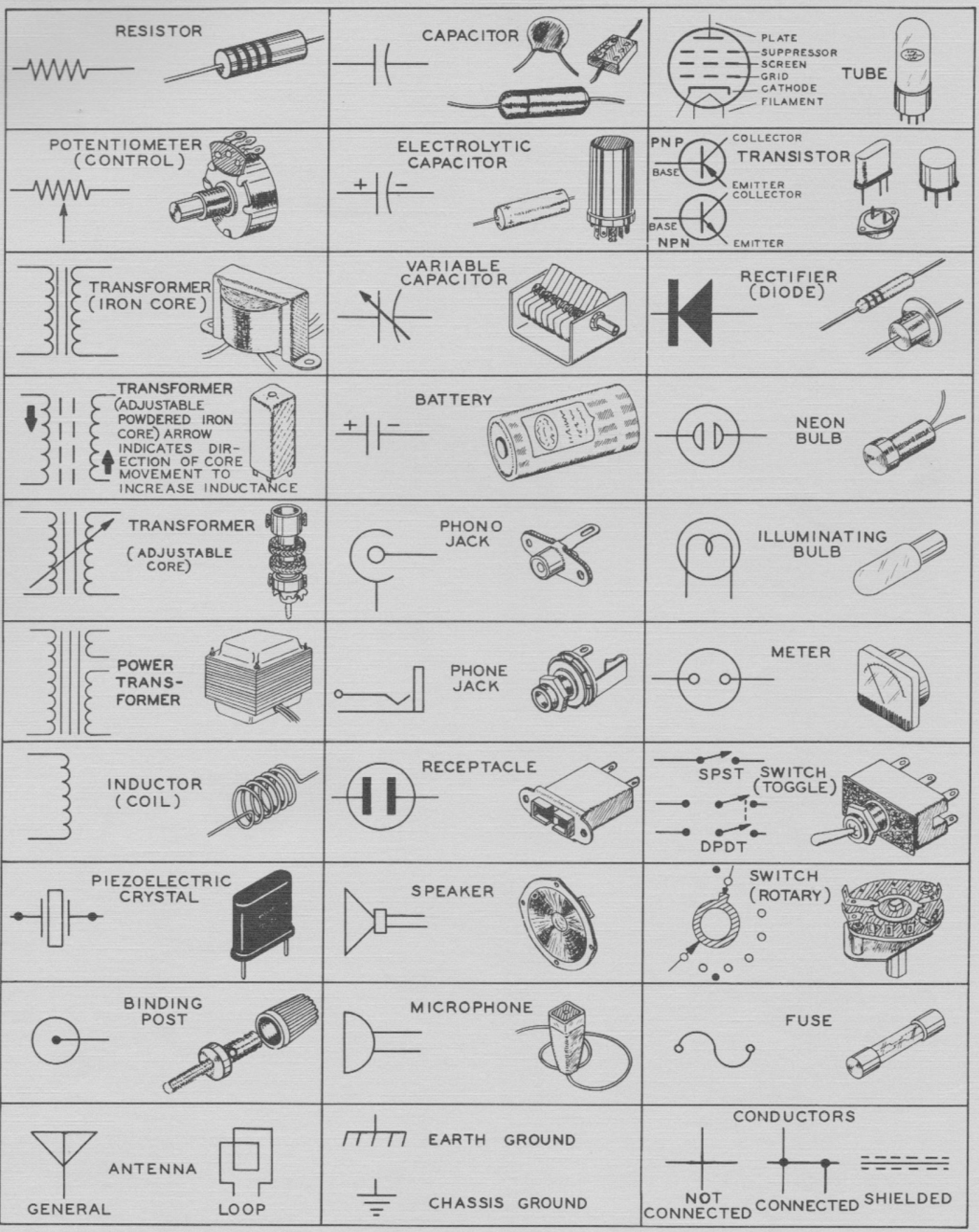
PIN 9 OF V101 V102, AND V103

NOTES:

1. REFER TO THE X-RAY VIEWS FOR THE PHYSICAL LOCATION OF PARTS.
2. ALL PARTS ARE MOUNTED ON THE MAIN CIRCUIT BOARD, THE READOUT CIRCUIT BOARD AND THE KEY CIRCUIT BOARD.
3. ALL RESISTORS ARE 1/2 WATT. RESISTOR VALUES ARE IN OHMS (K=1000, M= 1,000,000).
4. ALL CAPACITOR VALUES LESS THAN 1 ARE IN µF. ALL CAPACITOR VALUES OF 1 OR ABOVE ARE IN pF UNLESS MARKED OTHERWISE.
5. DC VOLTAGE MEASUREMENTS WERE TAKEN WITH A HIGH IMPEDANCE INPUT VOLTMETER FROM THE POINT INDICATED TO CIRCUIT BOARD GROUND. VOLTAGES MAY VARY ±20%.
6. ⬭ THIS SYMBOL INDICATES A DC VOLTAGE.
7. ▽ THIS SYMBOL INDICATES CIRCUIT BOARD GROUND.
8. □ THIS SYMBOL INDICATES A CONNECTION TO A CIRCUIT BOARD.
9. THE FIXED DECIMAL IS SHOWN WIRED BETWEEN THE FIRST AND SECOND DIGITS TO INDICATE TENTHS.
10. ◯ THIS SYMBOL INDICATES POWER SUPPLY TEST POINTS.

TYPICAL COMPONENT TYPES

This chart is a guide to commonly used types of electronic components. The symbols and related illustrations should prove helpful in identifying most parts and reading the schematic diagrams.



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